THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 42. Thursday, March 13, 1930. No. 708

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial: 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,

49, WELLINGTON STREET, LONDON, W.C.2.

Telegraphic Address: "Zacatecas, Rand, London."
Telephone: Temple Bar 3951 (4 lines).

Contents.

	PAGE
Forthcoming Events	189
Straws in the Wind	189
Welding and the Foundry Industry	189
The Physical Properties of Foundry Coke	190
Random Shots	190
Institute of Metals	191
A New Brick-Dressing Machine	192
The Light-Castings Industry	192
The Forthcoming French Foundry Inspection Tour	192
An Outline of the Application of Enamels to Cast Iron	193
German Steel and the World Market	194
Scrap Iron and Steel from France	194
Welding Cast Iron	195
Publications Received	196
Book Review	196
Foundry Training Abroad	197
Continental Steel Cartels	197
Increasing Foundry Production with Existing Box Plant	198
A Catalogue of American Industry Sent to Russia	198
A Review of Modern Cupola Practice	199
The Copper Situation	201
Catalogue Received	201
Beryllium	202
Trade Talk	204
New Companies	204
Personal	204
Obituary	204
Contracts Open	204
Reports and Dividends	204
Iron and Steel Markets	206
Students' Corner	206

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

Institute of British Foundrymen.

PRESIDENT: 1929-30:

Wesley Lambert,
J. Stone & Company, Limited, Deptford, London, S.E.14.

LIST OF SECRETARIES—

General Secretary: T. Makemson, Saint John Street Chambers, Deansgate, Manchester. London Office: 49, Wellington Street, London, W.C.2.

Birmingham: F. K. Neath, 24, St. Paul's Square, Birmingham.

Sheffield: T. R. Walker, 26, Castlewood Road, Fulwood, Sheffield.

Scottish: J. Bell, 60, St. Enoch Square, Glasgow.

Lancashire: H. Stead, 1st/36, Cheetham Hill Road, Stalybridge, Cheshire.

London: H. G. Sommerfield, Charterhouse Chambers, Charterhouse Square, London, E.C.1.

Newcastle-upon-Tyne: F. Sanderson, 15, Handyside Arcade, Newcastle-upon-Tyne.

East Midlands: H. Bunting, 82, Otter Street, Derby.

West Riding of Yorkshire Branch: S. W. Wise, 110, Pullan Avenue, Eccleshill, Bradford.

Wales and Monmouth Branch: J. J. McClelland, M.I.Mech.E., Druslyn, Bishops Road, Whitchurch, Glam.

Middlesbrough: F. A. Harper, "The Briars," Bishopton Road, Stockton-on-Tees.

Foundry Trades Equipment and Supplies Association.

President: H. Winterton,
Kelvinvale Mills, Maryhill, Glasgow.

Secretary: K. W. Bridges, Avenue Chambers, Southampton Row, London, W.C.1.

Welsh Engineers' and Founders' Association.

Secretary: E. J. Griffiths, 20, Fisher Street, Swansea.

Forthcoming Events.

MARCH 18.

Sheffield Metallurgical Association:—Ordinary meeting at Sheffield. "Question Night."

Co-ordinating Committee:—Combined meeting at Birmingham. "Nickel-Chromium Alloys," Paper by W. R. Barclay, O.B.E.

Institute of British Foundrymen.

MARCH 15.

Wales and Monmouth Branch:—Lecture at Pontypridd. "Steel Founding," by R. J. Richardson.

East Midlands Branch:—Ordinary meeting at Leicester. "Heavy Green and Dry Sand Moulding Practice," Paper by C. H. Brown.

MARCH 20.

London Branch:—Ordinary meeting at the Engineers' Club, London. "Recent German Foundry Developments," by Dr. S. G. Werner, President of the German Ironfoundry Employers' Federation.

Straws in the Wind.

Some short time ago we pointed out in these columns the way in which investigation of the twin subjects of cast iron and the founding process changed its direction from time to time. We suggested that the focus of interest was shifting—or was about to shift—from what might be termed the internal problems (those of the composition of the metal, alloy additions, etc.) to the external problems of shop process, temperature, auxiliary materials and so forth. These external problems have been, and to a large extent still are, regarded as subordinate in importance.

Several recent developments go to bear out our view. The first is the interesting series of investigations on coal dust made by Mr. Ben Hird, and by him presented to the London Convention in June last. These investigations have since been discussed by a number of the branches of the I.B.F., and always with the greatest interest and with an expression of appreciation for their pioneering character. It has been revealed by these and kindred discussions that in fact there is a vast range of problems whose existence we have only begun to suspect, and whose bearing on the material with which we are concerned is a great deal closer than has hitherto been believed. An equally pertinent development is the highly controversial question of alterations or alternatives to the cupola, which has for so long been accepted as axiomatic in the foundry trade.

To some extent such a change of focus must take place in all branches of the metallurgical industries. Scientific knowledge begins with the simple and goes on to the complex; it begins with the material and it goes on to the process. Moreover, it brings in its train a growing appreciation of the value of technical control, and, having analysed and attempted to improve the material, it goes on to analyse and attempt to improve the process. But in the case of cast iron the question is complicated by the fact that the material is more closely affected by the process to which it is subjected than any other. Twice—first in the cupola and again in the mould—does it come into direct contact with what may be termed auxiliary materials—coke, moulding sand, refractories. Complete technical control of cast metal, therefore, does not begin and end with an investigation of the metal itself. It begins with the cupola and it ends with the mould, and in between it touches every branch of foundry practice and every item of foundry supplies. It covers the design of cupola and ladle, the lay-out of the foundry, the method of working. It covers coke and sand and refractories. It covers speed of melting and temperature. If investigation of these questions will help to improve the product of the foundry, then such investigation cannot and must not be neglected. Our position in competition with the producers of other metals is not so strong that we can afford to neglect refinements of which they are making free use. Evidence is not lacking to show that foundrymen are waking up to these facts, and the circumstance cannot fail to react favourably on the industry.

Welding and the Foundry Industry.

There is no subject to which the foundry executive should pay more attention than that of welding. It is both his servant and competitor. In the former capacity, it renders great service in covering up minor defects, and every known means of welding are utilised. For minor defects occurring on thin sectioned cast-iron castings, such as baths, the electric method is probably the best, as no preheating is required; for heavier sections, oxy-acetylene, or the Thermit processes, suggest themselves as superior. Again, this very general statement requires modification when applied to steel and the non-ferrous alloys.

Allied to welding is the problem of the cutting-up of scrap or removing runners, etc., and here the oxygen blowpipe is supreme as a metallurgical process in competition with hack, band saw or other mechanical cutting processes.

A third phase of welding is that of the outside welder, who plies his trade in the direction of repairing castings broken in industrial use. He apparently has an uncanny knowledge of the cost of a replace casting, and arranges his price to be one-quarter of this figure. It has been stated that this type of business robs the foundry industry of £1,000,000 worth of orders per year.

The fourth aspect of welding is that of a process competing with foundry work. Though we hate to confess it, the welder sets about his business in a very erudite fashion. He tackles his problems in a manner worthy of emulation by the foundry industry. Primarily, some of the more enterprising manufacturers of welding apparatus have well-equipped schools for training entrants to the industry; they have organised their own research laboratories, employing high-grade metallurgists; and finally, what is more important, they take the designs of castings and redraw them to conform with the best principles of welded structures. It is stated that many types of bedplates can be built up at a price less than it costs to make the pattern if the article were cast.

It should be borne in mind, however, that up to now, so far as we are aware, welding machines are single-purpose tools and require the whole-time assistance of one operator. Thus they do not lend themselves to quantity production any more than does a continuous casting process. The potentialities of welding must not be underrated by the founder, and we are definitely of opinion that as welding is, like castings manufacture, a combination of engineering and metallurgy, the up-to-date founder is best qualified to embrace this trade as an adjunct to his industry.

XUM

The Physical Properties of Foundry Coke.

A meeting of the East Midlands Branch of the Institute of British Foundrymen was held on February 15 at Derby, Mr. J. Lucas presiding, when Prof. H. V. A. Briscoe, D.Sc., of Newcastle-upon-Tyne, gave a Paper on "The Physical Properties of Foundry Coke." The Paper was previously presented at a joint meeting of the Newcastle and Middlesbrough Branches of the Institute, and was published in The Foundry Trade Journal, April 25, 1929, page 307. The following is an abstract of the discussion which followed:—

Mr. J. Lucas (chairman) said the Paper had been very instructive, and one of which they should be able to make great use. One matter he had appreciated was that the lecturer had been content not only with the laboratory investigations, but had actually been into the real foundry to prove some of the results.

Mr. E. A. Peace said that with regard to the strength of coke, most foundrymen disliked to see coke "arrive" that was badly broken up. Some was broken up during transit and some was dumped into bunkers and then dumped out again for charging the cupola. A soft coke broke a great deal, either by virtue of the softness or by contact with the atmosphere. The foundries, or some of them, objected to using small coke. One matter of which he was ignorant was fissures and porosity; fissures had always impressed him as indicating weak coke. He wondered whether the porosity, apart from fissures, was greatly important. One method was to judge them by the blackness at the ends. Foundrymen usually liked a bright and silvery coke.

Prof. Briscoe said that much effort had been spent in investigating if there was any connection between porosity of coal and its harder qualities. Every sample of coke had its porosity determined, but there was not a single case of porosity that had anything to do with the behaviour of the coke. That, however, was the conclusion which had been arrived at up to the present. As regards coarse fractures and porosity he thought they could have a variety of qualities and there would be no difference in the porosity. At the moment he could not attach any significance to the porosity of coke, and did not think the presence of graphite had any detrimental effect on the utility of coke.

Mr. H. Pemberton said he had had some experience of coke, its various burning natures and properties, and he did not attach too much importance either to the fissures or to the shatter or other tests. At the same time, he thought Prof. Briscoe was moving on the right lines. The subject was as yet in its infancy. The tests had shown them what the Research Committees were doing. In his opinion, the coke that gave them the best practical results was that of about 2 in. or 3 in. With large coke the heat was all in one place. Had Prof. Briscoe had any experience of the crushing strength of the coke in conjunction with temperatures? They could get the shatter tests and the trommel tests, but that was outside the furnace. Foundrymen wanted to know the result of the pressure of hot coke. He did not attach too much importance to the black and silvery cokes. One of the old-fashioned methods was to place a piece of coke into water and note the volume that rose to the surface. Prof. Briscoe had shown that there was more in the properties of coke than was given in the chemical analysis.

Prof. Briscoe said that the size of coke depended on the particular size and type of the furnace, whilst so far as strength was concerned he admitted that that was at present a difficult question to answer. He had a strong opinion that in all probability the strength of coke did not fall off at high temperatures as other materials did. There was nothing in its behaviour that became weaker in the rise of temperature. It was quite true they could get the same results with a dozen different types of coke..

Mr. H. Pemberton, speaking of the temperature and the crushing strength of coke, said that some years ago he had a different kind of coke each month, which differed in its results from another sort used another month.

Mr. T. Goodwin thought that the suitability test was the most important of all. The difference in the size of coke for charging the cupola showed that the shatter test was of little use.

Prof. Briscoe said he did not want that impression to be implied, because he was convinced that if the shatter test was used in the proper way it was of the greatest possible utility. If they had a coke delivered to them continually from one particular source and delivered in the same fashion, a shatter test similar to the one given was, in his opinion, an excellent indication of its quality. If coke was sent on the railway different results were obtained. Although the shatter test was one of the best, they must also remember that it had no relation to the size of coke. He would advise them always to take a shatter test at the same place. Although a coke might be quite small it might show a good shatter index.

Mr. J. C. Hallamore raised the question as to the size of the coke compared with that of the cupola. He had been glad to hear Prof. Briscoe bring the cupola down to one of 18 in.; because he at first thought it had only to do with the large cupolas. Personally, he was using one of 18 in., but he would like to know what size ought to be used. The larger the coke used at his (the speaker's) foundry, the better, quicker and hotter did they get the cupola. With regard to wetting coke, he would remind them that it had been said on many occasions that it gave better results.

Prof. Briscoe said that wherever one talked to foundrymen about coke the question of wetting it was always introduced. He was opposed to the wetting of coke, as he did not think they could gain anything by it. He disagreed with the "wetters" because he was of the opinion that the water could not penetrate anywhere near where it would affect the melting of the iron. What it did was to abstract a certain amount of heat which otherwise would have gone into the other part of the charge from the waste gases. If water was put on coke it took time to evaporate and therefore absorbed some of the heat which might have heated the iron. Wet coke did not affect melting conditions.

Mr. J. F. Measures asked why they should always get the cupola hotter on a wet day.

Prof. Briscoe said he did not know. It was a strange idea, in which he did not believe. He was of the opinion that they could probably run a 5-ft. cupola on a 5-in. coke.

Mr. J. Lucas said undoubtedly the soft coke did not break up, and in consequence they got bad melting conditions, and secondly, it caused trouble. It was hoped that the experiments carried out by the Research Committees would aid producers of foundry coke to standardise the quality of their supplies.

Prof. Briscoe thought the coke consumers had the remedy by beginning with the coke manufacturers and the shatter-test. They could then say, "I want such a coke," naming the shatter-test.

Mr. P. A. Russell, who proposed a vote of thanks to Prof. Briscoe, said there was little in the address to which they could properly object. The subject had been well covered from a scientific point of view. Personally, he had been somewhat disappointed with the shatter-tests because they fell short of his expectations. The Fuel Research Committee had much farther to go. Mr. E. Stevenson seconded the proposal, and Prof. Briscoe suitably replied.

Random Shots.

Harking back to my last week's stories, a friend reminds me of the American who invented a knife with a curved edge, so that the peas wouldn't roll off! . . . I also said something about the way in which the British Industries Fair makes its presence felt in the Midlands. A correspondent has since sent me a number of cuttings from local papers that confirm my view. They are not specific accounts of the Fair, nor yet of Ministerial visits, official luncheons or relevant statistics; all these things were to be found at the time in any paper, though locally they naturally received more prominence. No, the striking thing was the way in which the Fair invaded gossip columns, humorous features, notes and news in brief, and even, I am told, the home page! In particular, the two following stories, both from the same source, will illustrate my point. Certainly the first, and possibly the second, would never have seen the light of day—or should I say, in this case, of evening?—at any other time.

* * *

A Black Country moulder was going round the Fair, and he was shown some small castings—rather a neat job, as a matter of fact—made at Willenhall. "D'you call that moulding?" said he with great contempt. "Why, at our works in Smethwick the hole for one of our castings weighs two tons!"

* * *

An American firm bought a business, and, wanting some good salesmen, they advertised, and received many applications. Among the men selected was one whose testimonial declared him to be the first salesman in the world. After some weeks on the road this expert came back and saw the manager. "I thought I was the finest salesman in the world," he admitted ruefully, "but I am not. I am prepared to take second place. The man who sold you this business is easily the first!"

* * *

Some extraordinarily interesting figures were given recently by an official of the Ministry of Labour, who declared that we are creating a false impression in our own and other people's minds in the matter of unemployment. He compared our own figure of 12.6 per cent. unemployed with 20 per cent. in Germany, 12.5 per cent. in Denmark, 12.9 per cent. in Norway, 16.6 per cent. in Sweden. Canada has 11.4 per cent. unemployed and New Zealand 9.4. Less easily compared figures come from the United States, where the percentage is 12 among organised workers and may be presumed higher among unorganised workers; from France, where the total is 12,708, and from Austria, where there are 226,567 unemployed out of a population of 6,500,000. The only one of these figures that we have any cause to envy is the French figure, and that requires comparison with the total population figure before it can be compared fairly. It would be interesting to know just how and why the theory was originated that Great Britain is the world's worst sufferer from unemployment. If these figures are to be relied on, then it just isn't true, and it is high time we ceased to labour under the delusion that we are in this respect a sort of "least-favoured nation."

Marksman.

Institute of Metals.

TWENTY-SECOND ANNUAL GENERAL MEETING, HELD IN LONDON, MARCH 12 AND 13, 1930.

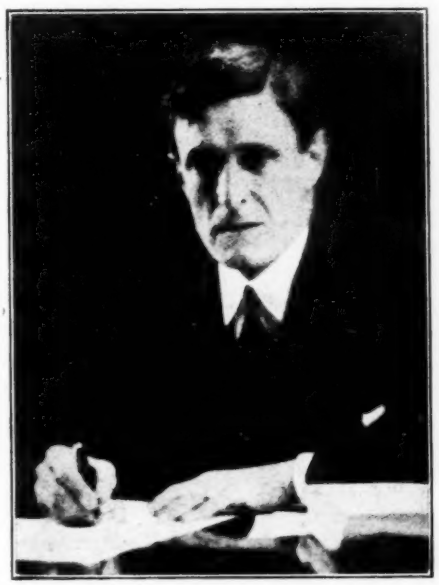
At the twenty-second annual general meeting of the Institute of Metals, which opened in London yesterday, the retiring President, Dr. W. Rosenhain, F.R.S., inducted the incoming President, Dr. R. Seligman, into the chair. The Secretary presented the Report of Council for the past year, which, *inter alia*, stated that the year had been notable for some incidents of special interest in the history of the Institute. The twenty-first annual general meeting of the Institute was marked by a "coming-of-age" celebration, which saw the Institute's membership pass the 2,000 mark. On this occasion, in addition to the annual dinner, a reception and conversazione was held, by the courtesy of the Director of the Museums, at the Science Museum, South Kensington. Exhibits of objects of interest in connection with the activities of the Institute were arranged, and a large number of members and guests attended what was generally regarded as a highly successful gathering.

In September the Institute held its annual autumn meeting for the first time in Germany. The meeting was held at Düsseldorf, by invitation of the Verein Deutscher Ingenieure and of the Deutsche Gesellschaft für Metallkunde, at a date which made it consecutive with the annual meeting of the latter society. At the invitation of the Deutsche Gesellschaft für Metallkunde, the President delivered before that society an inaugural "guest lecture," choosing as his subject "Physics and Metallurgy." Members of the Institute were invited to attend the meeting, and members of the German society were invited to attend the autumn meeting of the Institute of Metals: number of German metallurgists responded to this invitation. The autumn meeting at Düsseldorf was marked by one of the largest attendances of members and ladies—310 in all, including representatives of 18 nationalities—which has yet been recorded at any autumn meeting—a fact which confirms the opinion of the Council that autumn meetings abroad, at suitably selected centres, are a welcome feature in the arrangements of the Institute.

International Research.

The successful meeting of the Institute at Düsseldorf, following upon the meeting of the German society, brought forth the suggestion that closer international co-operation was desirable, particularly in regard to metallurgical research. This suggestion was warmly taken up by the French and German members of the Institute present at Düsseldorf and, as a result, an effort has been made to bring about a preliminary conference in London for the purpose of discussing the possibility of forming an International Metallurgical Research Organisation, which should secure closer co-operation in the future. The Council has placed the facilities of the Institute of Metals at the disposal of this preliminary conference, and it is hoped that successful results will be achieved.

Another important development during the past year is the decision of the Council to participate in the movement for the erection of a joint building for the purpose of housing a number of scientific and technical societies which at present are scattered in offices in various buildings in different parts of London. The scheme for a joint building originated with the idea that the principal metallurgical societies, including the Institution of Mining and Metallurgy, the Iron and Steel Institute, and the Institute of Metals, should be accommodated in a single building. The scheme has, however, been extended to include a considerable number of other societies and institutions, including an important group of chemical societies. The Institute has been actively represented on the various committees formed with a view to exploring the possibilities of such a scheme and, subsequently, of organising an appeal for securing the necessary funds. The scheme has now progressed to a considerable extent; substantial financial contributions have been promised from a number of sources, and it is hoped that the purchase of a site and the erection of a building may proceed in the near future. In deciding that the Institute should participate in this scheme, the Council feels that by co-operation with other technical and scientific bodies in this way the best interests of the Institute will be served. It is anticipated that not only will such a scheme provide better accommodation for the actual offices of the Institute, as well as the use of a lecture theatre, but also that it will facilitate closer co-operation between the participating societies, with possibly considerable resulting economies—particularly in regard to their publications—while it will also secure the more effective presentation of the views of technical and scientific bodies on all questions of public importance with which they are concerned. While the Institute is now fully committed to participation in the joint building scheme, it should be noted that beyond a small contribution to the preliminary expenses, no financial obligations have been incurred or contemplated beyond the undertaking that when the building is ready the Institute will rent accommodation at least equal to its present rooms at a total cost not greater than is now paid.



Dr. R. Seligman, P.H. nat.D.

(The Recently-Elected President of the Institute of Metals).

Roll of the Institute.

The number of members on the roll of the Institute has increased substantially during the year. On December 31, 1929, the totals for the various classes of membership were as follows:—Honorary members, 5; fellows, 9; ordinary members, 2,035, and student members, 73; total, 2,122.

One additional name was added during the year to the list of honorary members—that of Prof. Dr. G. Tammann, the doyen of German metallurgists.

Because of the eminence of their service to the Institute, and in commemoration of its coming-of-age, the Council elected as Fellows the President, Dr. W. Rosenhain, F.R.S., and the six surviving past-Presidents: Prof. Sir Harold Carpenter, Kt., M.A., Ph.D., A.R.S.M., F.R.S.; Sir John Dewrance, G.B.E.; Engineer Vice-Admiral Sir George Goodwin, K.C.B., LL.D.; Engineer Vice-Admiral Sir Henry J. Oram, K.C.B., F.R.S.; Leonard Sumner, O.B.E., M.Sc.; and Prof. T. Turner, M.Sc., A.R.S.M.

Meeting in America.

Further steps have been taken in the matter of the visit of the Institute to America. A draft itinerary has been prepared in consultation with the Iron and Steel Institute, the members of which will be visiting America at the same time as the members of the Institute of Metals. The present proposal is that members of both Institutes should leave England for New York early in September, 1932, returning from Montreal about the end of that month.

Corrosion Research.

Proposals were made during the year for the transfer to the British Non-Ferrous Metals Research Association of the control of the research which has been conducted continuously by the Corrosion Research Committee of the Institute of Metals since 1910. As the Committee's financial year ended on December 31, the transfer was conveniently effected as from January 1.

Henceforth the work will be controlled, directed, and financed by the Research Association. It will be continued on its present general lines by the Investigator (Mr. R. May, A.R.S.M.), working in the laboratories of the Royal School of Mines, under the supervision and guidance of Prof. Sir Harold Carpenter. It is understood that the sub-committee responsible for the work will include a strong representation of the Institute of Metals, and—if possible—of some of the users of condenser tubes who have been members of the Corrosion Research Committee. In order to mark the origin and continuity of the work it has been suggested by the Research Association that the investigation should in future be known as "The Institute of Metals Corrosion Research."

Election of Officers.

The Secretary announced that the Council for the year 1930 had been elected as follows:—

President.—Dr. R. Seligman.

Vice-Presidents.—Mr. W. R. Barclay, C.B.E.; Mr. T. Bolton, J.P.; Lieut.-Col. Sir Henry Fowler, K.B.E.; Prof. D. Hanson, D.Sc.; Dr. R. S. Hutton, D.Sc.; Engineer Vice-Admiral R. W. Skelton, C.B.

Honorary Treasurer.—Mr. John Fry.

Members of Council.—Prof. C. H. Desch, F.R.S.; Mr. R. Lloyd Gibbins; Mr. H. H. A. Greer, J.P.; Dr. A. G. C. Gwyer; Mr. Wesley Lambert; Mr. H. C. Lancaster; Dr. H. Moore, O.B.E., D.Sc.; Mr. A. H. Mundey; Mr. H. A. Ruck-Keene; Dr. S. W. Smith, D.Sc.; Mr. A. J. G. Smout; Mr. James Steven; Prof. F. C. Thompson, D.Met.; Mr. F. Tomlinson; Mr. W. G. Turner, O.B.E., and Mr. H. B. Weeks.

International Combustion, Limited, Africa House, Kingsway, London, W.C.2, announce the receipt by their associates, the Société Anonyme des Foyers Automatiques, of Paris, of two contracts for Wood type steam generators. The first order, for the Quaregnon Power Station, comprises three steam generators having an evaporation of 190,000 to 225,000 lbs. per hour at 950 lbs. pressure and 840 deg. Fah. final temperature. The boilers will normally be fired with pulverised coal, but provision will be made for using as fuel dehydrogenated coke-oven gas. The second order is for a steam generator of a similar design evaporating 80,000 to 90,000 lbs. per hour at a pressure of 400 lbs. per sq. in. and a final temperature of 800 deg. Fah. This unit will also be fired with pulverised fuel, and is intended for the Hensies Pommeroeul Collieries.

A New Brick-Dressing Machine.

When for many years we were in charge of furnace construction in the various countries of Europe, we often felt the necessity for a machine which would convert the product of the refractory brick manufacturers into mathematically rectangular shapes. In our experience, we never found that the grout or cement available was as good as the actual brick. Therefore, we made every endeavour to minimise the size of the joints. Then, again, our experience taught us that any brick under pressure through irregularity of surface lowered its melting point and reduced the life of the structure. This experience we detailed in a Paper* we presented to the Institute of Metals. We are thus perfectly sincere in welcoming the Mathieu firebrick dressing machine, a new model of which has recently been placed upon the market by Messrs. L. Le Personne & Company, of 99, Cannon Street, London, E.C.4. The largest machine, Type A, which is illustrated in Fig. 1, requires a motor of 20 h.p. for its complete operation. It is capable of dealing with blocks up to 43 in. × 22 in. × 16 in., being provided with a sliding table having a 5 ft. 7 in. travel. It utilises a carborundum wheel of 24 in. dia. running at 950 r.p.m., and weighs about 33½ cwts. This machine is obviously designed for installation in fire-brickworks, blast-furnace, open-hearth, coke-oven plants, etc. There are available four types of machines, and for the majority of foundries the smallest, Type C, will probably make the greatest appeal. In this, the carborundum wheel, of 12 in. dia., running at 2,000 r.p.m., deals with bricks up to 14 in. × 10 in. × 7 in. It requires a 3-h.p. motor for driving the wheel and the dust-extraction fan, the table, having a 2 ft. 2 in. travel, is worked by hand. The machine weighs about 12 cwts. The dust is automatically bagged, and, instead of injuring the men, now becomes a clean and valuable by-product. It is easy to visualise a dual economy to be associated with the successful operation of such machines. Primarily, the actual dressing of bricks becomes a much quicker operation, whilst the incorporation of perfectly fitting bricks economises construction time, and from general experience it can safely be predicted that a much longer life can be associated with what is after all a sanely built structure.

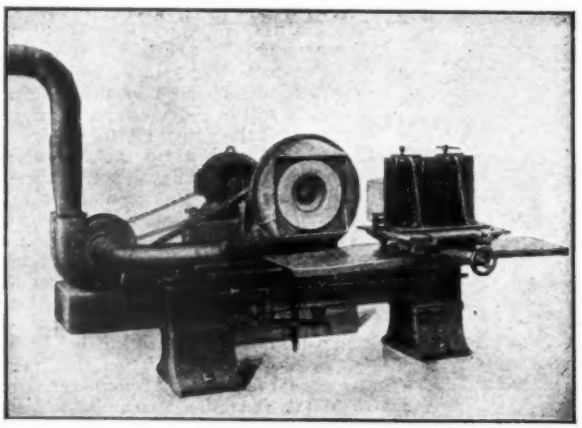


Fig. 1.—Type A of New Model of the Mathieu Machine.

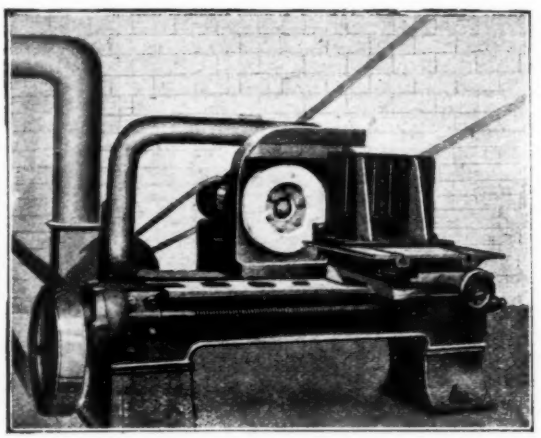


Fig. 2. Type B: Model of a Lighter Character.

Sizing Blast Furnace Materials.—The Department of Commerce, U.S. Bureau of Mines, has issued report No. 2,982, describing a method for comparison of the size of materials used in blast-furnace burdens. The method employs screen analysis of the material. Examples are given taken from actual operation, and it is believed that the method should afford a basis for comparison of the size of materials used in blast-furnace practice.

* See Foundry Trade Journal, February 19, 1925, page 153.

The Light-Castings Industry.

An alarming increase in the amount of light-casting goods imported to this country from abroad is intimated in the annual report of the Ironfounding Workers' Association just issued. Within the short space of seven years, foreign competition has laid a heavy burden on the iron-foundries of the country, and Falkirk in common with other towns is still suffering from the depression. The question is dealt with in the extracts from the report given below:—During the last three months the Executive, together with the Stove Grate Workers and the National Union of Foundry Workers, have had under consideration the question of the volume of trade and the price of goods that are being imported into this country in connection with the material required for housing schemes which the light castings trade manufacture. In making a survey of the position it has been found that the importation has increased steadily since 1923; in one of the articles alone 3,013 tons to 10,931 in 1927, the value of which in 1923 was £99,122 and in 1927 £307,208. This importation shows the alarming increase in these years. Since 1927 the importation has decreased to some extent, as in 1928 there was imported 8,256 tons, valued at £221,860, and for the first nine months of 1929 the tons imported were 4,968 and the value was £137,790. In this connection the report states it should be explained that the reduction of importation during the last two years can be accounted for because of a reduction in price of the home-made article, as both the employer and employee have made and given reductions on the selling and producing prices of these goods. It is calculated that if the goods imported were all made in this country all the idle men in the light-castings industry would be fully employed.

In view, therefore, of the foregoing facts, the joint unions thought it desirable to petition the Minister of Health for a conference, so that all the facts pertaining to the situation could be placed before him with a view to having something done to encourage home industry, as is already stated the men wholly unemployed in the production of these castings for British houses could be fully employed. The additional cost of housing would be comparatively insignificant, and the return it would give to all concerned weighed very much with them, and in their opinion, in the interests of the industry and the workers, some steps should be taken to ensure that, where British prices were reasonable, preference should be given to British castings for British houses. Correspondence has taken place between the Minister and the Joint Committee, the result of which a circular has been issued to all corporations in Great Britain pressing the need for using British goods for British houses. Regarding the financial position of the Association during the year, very serious inroads have been made on the funds, but when the reasons of these inroads are considered, it will be seen that the deficit on the year's working has been caused by the rain-water strike which took place at the beginning of the year and lasted from January 1 to February 5, the sum expended being £7,045. The unemployment benefit for the year was £4,966. There remains on credit at the end of the year £32,528, showing a loss on the funds of £4,777 9s. 4d.

The Forthcoming French Foundry Inspection Tour.

It seems rather typical of the foundryman that he is unable to book an appointment for any period very far ahead. Thus we are informed by Mr. H. G. Sommerfield, Charterhouse Chambers, Charterhouse Square, London, E.C.4, that quite a number of members of the Institute of British Foundrymen have been unable to give a final decision as to their participation in the forthcoming inspection tour of French foundries. As previously announced, the party will leave London on March 23. Several important alterations are announced.

Primarily, a banquet is being offered by two French foundry associations to the members participating in the trip, to be held on Tuesday evening, March 25, at Restaurant Weber, 25, Rue Royale, Paris; and, secondly, the visit to the works of La Malleable, at Colombes, has been cancelled, and, consequently, this has varied the programme slightly. On Tuesday, March 25, a visit will be made to the Renault Company, where malleable and iron castings can be seen in operation; and the alternative visit to Montupet Foundry will be made on Wednesday afternoon at 2.30 p.m. Combined with this visit, it is proposed to drive through the Forest of Chantilly, which is, of course, very interesting, and eventually arrive at the works of Société Montupet to see the foundry.

Welding Research in America.

In order to help the construction industry to obtain safe and economical structures, the American Bureau of Standards in co-operation with the American Bridge Company has investigated welded connections for steel-frame buildings. These included tests on column splices formed by welding plates to the inside faces of the column flanges. The connection was made by bolting splice plates to these welded plates. The tests showed that the connections were adequate in strength to carry the loads for which they were designed.

An Outline of the Application of Enamels to Cast Iron.

By J. H. D. Bradshaw (Metallurgist, Bradley & Foster, Limited).

Enamel.

The term "enamel" is here used to denote the type of covering known as a vitreous enamel, and the following definition given by Claudius Popelin may be quoted, since this, notwithstanding its length, is the most clear and comprehensive definition yet enunciated:—

"Enamel is a glass fusible at a low temperature, and usually compounded of a mixture of borates and silicates. This mixture, originally colourless, combines with the greatest ease with all, or almost all, metallic oxides, under the influence of a pyrotechnic operation, thereby acquiring various bright or sober colours, according to the nature of the oxide, which the enameller can vary at will and place a comprehensive palette at his disposal."

Briefly considered, the process comprises three distinct stages, namely, (1) the preparation of the castings, (2) the preparation of the enamel, and (3) the application of the enamel to the castings. Each of these operations is, or should be, conducted in separate departments, so that dust and dirt (the ruination of many enamels) may be avoided.

Preparation of the Castings.

The production of suitable iron castings of correct composition for enamelling has already been discussed by the writer in a previous article,* wherein it was stated that the castings must be thoroughly cleaned by some method. The ideal process being a good sand blasting, employing a rather coarse sand. When thoroughly clean and free from rust and dirt, the castings are ready for enamelling after examining for surface defects.

Filling.

Unfortunately, in spite of this great improvement in the surface of the castings, it is inevitable that a great many castings, especially light stove parts, are bound to leave the foundry with some sand and blowholes. Many efforts have been made to develop a method of saving such castings from being rejected, and thus increasing the percentage of waste castings. An easily fusible "sulphur" stopping must be avoided at all costs for castings to be finished by enamelling, because during the subsequent firing in the enamelling operation the sulphur and carbon (composing this kind of stopping) will be evolved (as gases), producing a badly-blistered surface to the enamel. Unfortunately, however, this does not end the trouble, for the fumes of sulphur dioxide, floating about the muffle furnace, will produce a dull or "pig-skinned" surface. If an enamel is being used containing lead oxide it will be completely ruined, owing to the formation of lead sulphide. This will give the enamel a black surface which is impossible to remove.

The best method known to the writer for filling these sand- or blow-holes in the casting is by means of a refractory material with just sufficient clay and fluxing material to bind the whole together at the firing temperature. A formula for such a filling that has given excellent results consists of dry powdered quartz 4 parts, dry powdered enamelling clay 2 parts, and soft waste enamel 1 pint, the whole being well ground together with just sufficient water to form a plastic mass. In use, the filler must be well pressed into the hole, so that an "air pocket" may be avoided. In cases where a hole goes right through the casting, these are easily filled, as there is no danger of forming an air pocket. After filling, the casting must be thoroughly dried before being placed in the furnace.

Success has also been obtained by the use of some of the proprietary plastic fire-cements that are now on the market.

The Preparation of the Enamel.

The enamel is prepared in a shop as far removed from the foundry as possible, in order that the dust arising therefrom may cause as little damage to the enamels as possible, the production of the beautiful enamels so often admired demanding the most scrupulous care and cleanliness in all operations.

It has already been stated that, considered chemically, an enamel is glass. From a scientific point of view it may be regarded as a complex boro-sodium-potassium-aluminium-silicate, usually containing fluorine and generally coloured or rendered opaque by various metallic oxides. The question of exact chemical composition of suitable enamels for cast iron is considerably beyond the scope of the present article. However, the ideal enamel should be fairly thin, have a high gloss, possess good covering power, and offer great resistance towards attack by acid (particularly fruit acids) and dilute alkaline solutions. Its most essential feature, however, is that it must have a co-efficient of expansion approaching that of the cast iron to be enamelled, otherwise "crazing," and possibly chipping of the enamel will occur. How difficult it is to combine all of these properties in one and the same enamel formula can only be appreciated by those who have attempted the task. For example, an enamel having a good gloss usually contains a large percentage of fluxing material (borax, soda, potash) will have a low fusing-point, but will offer poor resistance towards acid attack, and may even be decomposed by water. On the other hand, an enamel with a high silica content (50 to 60 per cent.) will have a high fusing-point, rather difficult to work (especially as a powder), have poor gloss, but will possess great resistance towards acid attack. In other words, the acid-resistivity of an enamel increases directly as the percentage of silica increases. This also raises the fusing-point, but decreases the gloss.

An enamel is produced by thoroughly mixing and melting together such materials as borax, soda, saltpetre, cryolite, fluorspar, felspar and quartz, which are carefully weighed according to a trustworthy recipe or formula, thoroughly mixed, sieved and fused in a "frit" furnace.

The "frit" furnace is of the reverberatory type, the older ones being coal fired. This is not only an uneconomical way of firing, but has several other disadvantages. Dust and sometimes ashes are carried over into the batch of enamel being fused, which not only causes discoloration, but, more important still, it considerably increases the liability of the enamel to "blister" when subsequently fired on the castings, owing to inclusions of unoxidised carbonaceous matter.

A type of furnace rapidly gaining favour for this purpose is oil-fired. A typical example being "Podmore's Patent Frit Furnace," which is made in several sizes. This furnace is sufficiently hot for smelting purposes in about one to one and a-half hours after lighting, compared with the four to five hours required for the coal-fired type. Further, one has a clean furnace and atmosphere, they occupy less room and require little attention.

A revolving furnace is said to be used in several American works, but, so far as the writer is aware, none has been used in this country for this particular purpose.

The frit furnace works at a temperature of 900 to 1,600 deg. C., according to the class of enamel being produced, and the time required to produce a 400-lb. charge is approximately 2 hrs. Soft cast iron dusting-enamels should not be heated above 900 deg. C., especially if they contain tin oxide, otherwise a loss of covering power will be experienced, owing to this material going into solution instead of remaining in suspension.

When thoroughly mixed and molten, the enamel is splintered by running into clean cold water, held in tanks alongside the furnace. This produces the granular material known as "frit," which is much more easily ground than when the vitreous mass is allowed to cool normally. The "frit" is removed from the tanks as quickly as possible, weighed and ground in a stone or pebble mill, with suitable additions. These additions consist of tin oxide (or a substitute) for the production of a white enamel or suitable oxides for the production of coloured enamels. If the enamel is subsequently to be applied by the wet or swill method, then water, about 6 to 10 per cent. of prepared clay and a suitable "vehicle" are also added. The vehicles usually employed are Epsom salts ($MgSO_4$) and well-calcined magnesia (MgO). The function of the vehicle is to give the enamel that "creamy" consistency, so necessary to successful application. Without such additions the enamel would be unworkable and quickly settle to the bottom of the containing vessel.

Enamels to be applied to cast iron by the older dusting process are ground dry, that is, without a water or clay addition. In this case the metallic oxides for opacifying or colouring are fused in the frit, especially is this the case when producing transparent enamels. It may be pointed out here, that, as a general rule, any substance fused in the frit tends to remain in solution, thereby producing transparency, while any material added at the mill will remain in suspension, thereby producing, or rather tending to produce opacity. As an illustration of this point may be cited an enamel opacified by means of cryolite, is perfectly transparent when molten, also upon sudden quenching, but when coated and fused on the castings and allowed to cool normally becomes opaque. The explanation of this phenomenon is, of course, simple; the fluorine is soluble in the molten enamel, but as the latter cools so its solubility decreases and the fluorine is thrown out of solution (therefore it must be held in suspension) thereby producing the turbidity.

Types of Enamels.

There are three types of vitreous enamels, namely opaque, semi-opaque, and transparent, familiar examples of the opaque type being the porcelain-enamelled baths, sinks, hollowware, etc., well known to everyone. The semi-opaque is usually employed as a protective coating against rust, extensively used for the inside of cast-iron water cisterns, tubes, etc., and known as "grey glass enamel." The transparent type is used for the production of the beautiful imitation majolica effects, so familiar on cast-iron fire grates, stoves and general ornamental work. These transparent enamels usually contain a large proportion of lead oxide (PbO), say 40 to 60 per cent., and have an extremely low fusing-point.

The Application of the Enamel to the Castings.

Cast iron may be enamelled by two processes, known respectively as the "dry," or dusting process, and the "wet," or swill process. These methods are further modified at different works.

The Dusting Process.

This is by far the older process, having been practised since the year 1840. It consists essentially of heating the carefully-cleaned castings in a suitable type of muffle furnace to redness, withdrawing them, and upon them the finely-ground dry enamel is dusted by means of a sieve until the necessary thickness of coat is

D

* Foundry Trade Journal, January 9, 1930.

obtained. The casting is then replaced in the furnace until the enamel has melted, or "run up," as the enameller calls it. The process is rather expensive, especially for small castings, as each one has to be handled individually. When well executed, however, it produces beautiful porcelain-line surfaces. Large castings, such as baths and sinks, are enamelled by this method economically, as they "hold the heat" longer than smaller castings.

For the imitation majolica effects mentioned, these enamels being transparent, clay (an essential for wet enamelling) cannot be used owing to its opacifying effect. Majolica effects are produced by dusting a transparent enamel powder of the desired colour upon a red-hot casting that has already been coated with an opaque white enamel. The latter may have been obtained by either the dusting or wet process.

Sometimes a so-called "glaze" or "body" enamel is applied to the casting before proceeding with the final enamel. This glaze is usually an enamel containing about 60 to 70 per cent. silica, 10 per cent. alumina and 10 to 20 per cent. borax; is used wet and applied by means of a brush, swilling, or, better still, by spraying. Instead of using a glaze, some enamellers prefer to use a "flux" to prevent blistering. Fluxing, briefly considered, consists of heating the casting to redness in the furnace, withdrawing and giving a very light dusting of a special preparation. The castings are then replaced in the furnace until this flux has molten, withdrawn, and enamelling proceeded with in the usual manner. An excellent preparation that the writer finds to give good results for this purpose is made by thoroughly mixing together and sieving dry powdered quartz 2 parts and soft white enamel 1 part. These proportions can, of course, be varied (within reason) to suit the class of castings to be dealt with.

The Wet Process.

This method consists in coating the cold castings with an enamel in a liquid condition, rendered possible by the addition of clay, water and other substances. The process may be further subdivided into two classes, which for convenience we may call (*a*) the Continental process, and (*b*) the American process.

The Continental method originated in Germany about the year 1850, but, with the exception of one works, has not been adopted in this country. By this method the castings are first coated with a fairly thick coat of a refractory enamel, containing about 80 per cent. of silica, dried and placed in the hot muffle furnace until the castings are only dull-red. They are then withdrawn, cooled, and the coating (which then has a porous biscuit appearance) is moistened with clean water, followed by a coating of the final enamel applied either by "swilling" or spraying. When dry, the castings are returned to the muffle and heating continued until the enamel has run up.

The American method is of very recent date, and is essentially a modification of the process whereby steel articles are enamelled. As in the Continental process, two enamels are used, namely, the first coat and the finishing coat, both being applied in a liquid condition. In this case, however, the first coat is not refractory, but fusible, free, of course, from metallic oxides. Therefore, after firing, this enamel has a glossy surface, upon which (when cold) the second coat may be applied without any intermediate wetting operation. The principal feature to control when working this process is not to have the furnace too hot, or blistering is liable to occur. It is much better practice to have a comparatively "poor" muffle, so that an extra few minutes will not result in spoiling the whole batch of castings.

The operations of dusting, spraying, drying and firing may be repeated several times according to the finish desired. The castings are now enamelled, and one has a glossy finish that is durable and artistic; will defy varying temperatures, dirt, rust and water.

German Steel and the World Market.*

POST-WAR COMPETITIVE POSITION.

Germany is a country poor in ore reserves, the bulk of her supplies having to be imported from Sweden, Spain, North Africa and other countries. Before the war it was possible for Germany to cover at least a portion of her ore requirements from the then German Lorraine deposits, but all these ore deposits have passed over to France and with them the large and modern iron and steel works established there before the war. All these sources of supply consequently have not only been placed out of Germany's control, but they also contribute towards the strengthening of foreign competition in the world market. The same observation applies to the Upper Silesian district which was ceded to Poland. Not only the coal resources there but also almost all the ironworks have passed into foreign ownership, and, consequently, have likewise become competitors.

In other respects the centre of gravity of the steel industry in other parts of the world has also been much displaced by the issue of the war. The production in the United States has considerably increased, while Japan, India, Australia and Canada, which had formerly scarcely come into consideration, have embarked upon their own production, so that they are now able to meet their own requirements to a large extent. All these events react upon Germany, since every customer lost implies a loss of work for the German steel industry.

Table I.—*Output and Exports of Steel* (1 = 1,000 *tons*).

	Germany.		France.		Belgium-Luxemburg.		Great Britain.		United States.	
	Output.	Exports.	Output.	Exports.	Output.	Exports.	Output.	Exports.	Output.	Exports.
1913	18,935	4,788	4,428	495	3,734	1,408*	7,786	3,506	31,802	2,662
1928	14,517	3,550	9,630	4,116	6,501	4,415	8,662	3,495	52,369	2,277

* Excluding Luxemburg.

A perusal of Table I will show how matters have developed with the chief competitors, namely, Great Britain, France, Belgium, Luxemburg and the United States. The table shows in thousands of tons the production in those countries of crude steel and their respective exports of steel products. As compared with 1913 the output of crude steel in Germany declined from 18,935,000 tons to 14,517,000 in 1928, or by almost one-fourth; in France it increased from 4,428,000 tons to 9,630,000, or by more than double; in Belgium-Luxemburg from 3,734,000 tons to 6,501,000 tons, or by almost 3,000,000 tons; in Great Britain from 7,786,000 tons to 8,662,000 tons, and in the United States from 31,802,000 tons to 52,369,000 tons, or by over 60 per cent.

However, the great change will only become evident when the exports of iron and steel by these countries is considered. Thus, as compared with 1913, (1) Germany exported 1,238,000 tons of iron and steel less in 1928 than in 1913; (2) France exported 3,621,000 tons more; (3) Belgium-Luxemburg exported about 3,000,000 tons more; (4) Great Britain exported 11,000 tons less; and (5) the United States exported 385,000 tons less than in 1913. The diminution in the case of the United States is of little significance; it simply shows that, despite a large increase in the production, the output was mainly consumed in the country itself, as it possesses such a receptive inland market as not to be dependent on a strong export trade. There are indications, however, that American steel will soon appear in larger quantities in the world markets than hitherto, with the result that the competition with Germany will become more serious. For the time being, the chief competitors of Germany are Great Britain, France and Belgium-Luxemburg. That the exports from Great Britain have slightly declined will prove a strong incentive to overtake her losses. In the case of France the exports will, perhaps, diminish in the near future to some extent, as her industries are prospering and the inland market is showing a growing capacity of absorption. Nevertheless France will permanently remain a strong competitor in the world market, as her costs of production are considerably less than in Germany. This remark applies even more forcibly to the Belgium-Luxemburg Customs Union, which has only a limited home market and is very largely dependent on the export trade. Every possible effort will be made to maintain, and even increase, the exports, and this will be bound to succeed, as the wages are much less in the Union than in Germany, and extensive supplies of iron ores exist in Luxemburg.

The two strongest competitors (France and Belgium-Luxemburg) have considerable advantages. Besides lower wages, they have lower railway rates and cheaper money (interest at between 6 and 7 per cent. as against 8 to 10 per cent. in Germany), together with lower taxes and social-welfare burdens. Moreover, Germany has to deliver to these countries large quantities of coal on reparation account, and their iron and steel works have been built up at the cost of Germany in the most modern form and with the latest technical equipment. Thus all round they have a considerable advantage over the German steel industry.

There is a considerable difference between the quality of the exports of Germany as compared with those of her Western neighbours, as the latter export chiefly heavy products, whereas the German exports (as well as those of Great Britain) are more highly-finished products. As an instance may be mentioned the exports of machines which contain about 90 per cent. of iron or steel. In this respect Germany has so far come off comparatively well, as the pre-war figure of about 596,000 tons in 1913 has almost been reached again at 538,000 tons in 1928 despite the losses through the war. Truly enough, France has trebled her exports of machines since 1913 and Belgium and Luxemburg have obtained an increase of 35 per cent. in the same interval. As a consequence Germany has every occasion for seeing to it that her efficiency in the construction of machines does not diminish, and at the same time she must endeavour to produce machinery as cheaply as possible to retain her foreign markets.

* Abstract from the "Kruppsche Mitteilungen."

Scrap Iron and Steel from France.

The arrangements made with the French Government as to the distribution among United Kingdom importers of the quantity of scrap metal allowed to be exported from France to this country during the year 1929 are to be maintained during 1930, the 30,000 metric tons allocated to Great Britain and Northern Ireland being available in equal quantities of 6,375 tons of old iron and 1,125 tons of scrap from new blooms, billets and castings in each of the four quarters of the year.

Authorisations to participate in the 1930 contingent will be issued to British firms by the Federated Associations of Scrap Iron, Steel, Metals and Machinery Merchants of Great Britain. Applications for authorisations should be made to the secretary of the Federation at Westminster Bank Buildings, 3, York Street, Manchester.

Welding Cast Iron.*

By W. Steel.

There would be nothing unusual in presenting a Paper on this subject to a meeting of welders or engineers. In presenting it to foundrymen a word of explanation is perhaps necessary. Foundrymen have no use for welding processes unless they be employed to remedy defects in castings which arise in the course of production. In the minds of some people the idea of welding a newly-made casting is akin to patching a new suit. The argument is the same, but the two things are totally different. A patch is a patch, no matter be it on a suit or casting; but an autogenous weld on cast iron restores orginal quality and oneness of structure, making the casting not like new, but as new. Safety is the chief factor to be considered, but, if welding can be relied upon to restore a broken machine part to vital service, wherein lies any objection to its use in the foundry. Justification for the use of welding in the foundry lies in the peculiar difficulties which attend the manufacture of castings.

Definition.

An autogenous weld is one in which metal is united to metal by melting or fusion. Such melting or fusion is induced by the application of heat. An autogenous weld on cast iron should in every respect equal, or at least approximately equal, the original section. Such welds should be homogeneous, sound, just as strong and also as workable as the rest of the casting on which they are made.

Softness of the weld metal is essential, and this necessity requires emphasis, as it is possible in welding cast iron to secure a very strong line of fusion, and yet find the weld, and area immediately surrounding it, extremely hard and unworkable. When this happens, it is sufficient to render the weld useless if machining operations have to be executed upon it. It is seldom, no matter which process is employed, that a weld on cast iron can be made without adding foreign metal, the composition of which will very largely determine the ultimate composition and quality of the welded section.

Every Job a Separate Problem.

Owing to the infinite variety of design, the variation in section in a single casting, difference in composition, its low tensile strength and entire lack of elasticity, every weld made on cast iron is a separate problem. Whilst this statement cannot be refuted, it is a fact established by experience, and supported by theory, that the proper observance of certain easily-defined procedure, though not infallible, can, generally speaking, be relied upon to ensure success.

The procedure in its proper sequence is as follows:—(1) Remove all foreign matter from the weld area, such as sand, grease, oil, paint and rust; (2) preheat the casting; (3) add the correct kind of filler metal, which should be silicious and free from manganese. Manganese favours the combination of carbon and iron, and, consequently, the formation of hard iron, whilst silicon has the opposite effect of throwing the carbon out of solution, thus influencing the formation of grey iron, soft and workable; and (4) last, but not least, it is important to allow the casting to cool slowly. If it has lost heat during the actual welding, it is sometimes wise to normalise by re-heating.

Alternative Welding Processes.

There exists four separate and distinct processes which may be employed to effect an autogenous weld on cast iron. There is a fifth method, which can be used to repair broken or defective parts, but as such repairs are not autogenous welds, this process will be considered later. The four autogenous processes are, in alphabetical order:— Burning-on process, electric-arc process, the oxy-acetylene process and the Thermit process.

Burning-on Process.

Welding a casting by burning-on is accomplished by pouring molten metal upon the affected parts until they are melted and fusion takes place. A sand mould is formed round the part to be treated so as to form a basin with an overflow level. The molten metal poured into this basin constitutes both the heating agent and also the filler material. The surplus metal is not wasted if run into another ladle, and may be used for casting core-irons, moulding-boxes or castings of secondary importance. Fusion with this process is not instantaneous, though melting temperature on the casting is generated very quickly. This method is very effective if properly done, and was made use of by foundrymen long before electric-arc or oxy-acetylene and Thermit processes were ever heard of.

Electric-Arc Process.

The electric-arc process of welding is accomplished by utilising the intense heat of the arc to melt the iron and filler metal, and so promote fusion. Two systems are available, the metallic arc and carbon arc. The former employs a metal electrode, which is also the filler material; the latter employs a carbon electrode, or pencil, and a separate filler medium. Fusion, though local, is in both applications instantaneous, though with the metallic-arc process progress is intermittent, as stops are necessary to renew the electrode.

Oxy-Acetylene Process.

The oxy-acetylene process requires two gases for its functioning, *i.e.*, oxygen and acetylene, which are mixed and combusted in a suitable type of blowpipe. The product of combustion is a flame with two zones, the inner zone having a temperature of from 2,000 to 3,000 deg. C. Unlike the electric arc, fusion is not instantaneous, nor can the heat of the flame be concentrated upon as small an area, adjacent metal being raised to a very high temperature.

Thermit Welding.

Thermit welding should be of interest to foundrymen, as it resembles the burning-on process. With this process a temperature not definitely ascertained, but estimated to be twice that of molten steel, is generated by the intense chemical reaction which follows ignition of a mixture of powdered aluminium and iron oxide. Steel punchings constitute the filler metal, and these are placed in a crucible, or in a mould surrounding the effected parts, together with the charge of Thermit, which is fired by the addition of a little magnesium. The parts to be welded are usually heated to redness, and melting and fusion is almost instantaneous.

Alternative Processes.

Having defined what constitutes an autogenous weld on cast iron, and described the alternative methods of making one, two questions naturally arise: (1) Can all four processes be relied upon to give satisfactory results? and (2) can any of the four claim superiority?

So long as one has to rely on heat to effect fusion, with the consequent phenomena of expansion and contraction, so long will the same problems associated with welding cast iron have to be solved, no matter which process be employed. As each process differs in method of application, and it is seldom that two cast-iron welding projects are ever alike in nature and location of defect, nor uniform in composition and design, it is possible to answer both questions in the affirmative. Each process may be better suited to apply under certain conditions than another. So far as burning-on and oxy-acetylene are concerned, there is no reason why ideal results should not be obtained, provided the same preparation and precautions are taken.

Speaking generally, foundrymen know more about cast iron, as cast iron, than welders do, but so far as welding is concerned, welders know more about welding cast iron than foundrymen know about welding it. The explanation of this seeming paradox lies in the fact that welders have made welding a whole-time job, whilst manufacturing castings is the foundrymen's job. Welding a casting by burning-on is regarded as a disagreeable casual necessity, which, as a rule, only comes along occasionally.

One encounters burns—good, bad and indifferent; good burns but hard welds; good burns rendered useless by expansion or contraction cracks. The author has seen burns good in every respect made in a third of the time oxy-acetylene welding would take. On the other hand, many a job has been lost in the foundry, as burning-on was impracticable, which could easily have been saved by the oxy-acetylene method.

Preheating Essential.

As with the burning-on and oxy-acetylene processes, preheating is usually essential, and this feature accounts very often for the major part of the cost of welding. Any system which could safely eliminate such labour and expense would be worth while adopting. Such advantage is often claimed for the electric-arc process—fusion being instantaneous, any heat generated is merely local and rapidly dissipated. Generation of heat can be further controlled by carrying on the work intermittently. The major claim made is, that the use of the arc eliminates expansion, or at least restricts it to such a small area that internal stresses are negligible and not liable to cause cracking or tearing. The advantages claimed are, more apparent than real. Personal experience is that, generally speaking, electric-arc welds on cast iron produce indifferent results.

Use of Electric Welding.

For filling sand pockets, deep holes, surface defects on unmachined surfaces on heavy sections, the electric-metallic arc is suggested as the most appropriate process to employ. The oxy-acetylene method would, for such classes of repair, require preheating to save gas and obtain fusion. Burning-on would necessitate the pouring of a large volume of metal, and without preheating would involve the risk of cracking the casting, and, if it did not elsewhere, the deposited metal certainly would, owing to adjoining sections being strong enough to stand the strain of expansion, which must be relieved in some way.

Despite assertions to the contrary, it is a fallacy to believe that because of the merely local application of heat and fusion no risk of expansion or contraction cracks attend the application of the arc process to cast iron. The very opposite is the case, for the instantaneous generation of welding heat confined to a small area will cause equally instantaneous expansion, followed by immediate contraction.

Welding of Cracks.

As the metal surrounding the weld area is cold, and, consequently, unyielding, the pent-up force of first expansion and second contraction will release itself, if greater than the strength of adjacent parts, by cracking them, or, if they are strong enough to stand up to the internal stresses in the weld, the force of expansion, like other forms of energy, will take the line of least resistance and move outwards or inwards; in the case of steel, buckling or warping takes place, but as iron possesses neither the elongation nor tensile qualities of steel, it will

* A Paper read before a joint meeting of the London Branch of the Institute of British Foundrymen, the Institute of Welding Engineers and the British Acetylene Association.

not buckle or warp, but simply crack. This fact can be easily demonstrated by taking two pieces of plate, one steel, one cast iron, say a foot square and ¼ in. thick. Start depositing metal or apply the arc in the centre of each, both plates being cold. The steel plate will rise in the centre and the corners will be drawn inwards. The iron plate will endeavour to follow suit, but, by reason of its composition, it cannot, and it will crack.

If the arc process is unsuitable if applied to a cold casting, the question arises: Is it suitable if preheating be employed? Preheating, as with the other two processes, will certainly safeguard against expansion and contraction troubles, but if this be necessary, then it robs the process of any advantage claimed for it over the others. As to the qualities of the weld, with available materials the results do not compare favourably with those produced by the oxy-acetylene process.

Electrodes.

A steel electrode is unsuitable, as the coefficient of iron and steel is not the same; in cooling, the steel deposit will tear away from the iron. A ferro-silicon rod, as used in the oxy-acetylene process, is unsuitable as an electrode, as it is difficult to maintain an arc. Such a rod can, however, be used in conjunction with the carbon arc, but even so, the resulting welds will usually prove to be hard and unmachinable. Under the intense heat of the arc, the silicon content will be largely oxidised, thus permitting the formation of combined carbon in the iron and a hard weld. It is true that progress has been made towards providing a suitable rod for welding cast iron electrically, but, in the author's opinion, such rods as are available do not compare favourably in results with those obtained by the oxy-acetylene process.

Thermit welding has its own particular sphere in the welding of steel, such as jointing, shafting, pipes, rails, etc. For welding cast iron the process has certain drawbacks, so that its use is governed by necessity; that is to say, it is only employed when other alternative methods are considered as impracticable. The disadvantages are:—(*a*) a steel filler is used, which is not a natural medium to employ for cast iron. In spite of the fact that ferro-silicon is added to the charge to control the carbon in the iron, the steel filler, or binding metal, is usually carbonised, and such welds are, as a rule, hard and difficult to machine, grinding being the only means of dressing them, and (*b*) anything which adds to, rather than eliminates the risk of expansion or contraction cracks developing, must inevitably increase the difficulty of making a successful weld. Even though preheating be employed, contraction cracks are likely to develop, as the expansion and contraction coefficient of Thermit metal is almost double that of cast iron.

Bronze Welding.

A real step towards the simplification of cast-iron repairs is the quite recent introduction of bronze welding, which is effected in conjunction with the oxy-acetylene flame. Instead of the iron-filler rod, a bronze rod is employed, which when deposited on iron or steel, previously heated to redness the equivalent of its own melting, which is 850 deg. C., surface alloys with ferrous metals, and thus produces a very strong joint. This process simplifies the welding of cast iron by doing that which the electric-arc process claims to do, but fails to accomplish; for bronze welding does actually eliminate to a great extent the necessity for preheating, not in every case, as some castings are so light in section and intricate in design that anything less than total preheating would prove fatal.

The virtue of this process lies in the fact that ferrous metals need only be heated to redness along the line of fracture, at which temperature the bronze will surface alloy with them. Some people insist that this process should be termed "brazing," as it does not produce an autogenous joint. Technically, the objection is sustained, but very often in practice the results justify the appellation of "weld." A bronze weld properly executed upon cast iron will often prove to be stronger than the original section, as, through the surface alloying action which has taken place, the higher tensile strength of the deposited bronze has been imparted to it.

Summary.

To sum up, the evidence seems all to be in favour of the oxy-acetylene process as the best method for general application. Welding cast iron by burning-on is only practicable in the foundry. It is a potential method of repair, not appreciated by welders and insufficiently studied by foundrymen. For the reasons given, the electric-arc process does not appear to be a suitable process for general application, though it has been used with singular success on rather singular work.

Thermit welding, like the electric-arc process, produces, when applied to cast iron, something in the nature of a compromise, the welds constituting carbonised steel difficult to machine. There are types of fractures, of course, for which Thermit is probably the only choice, such as broken roll-necks. As for bronze welding, the author is in a position to know that the value of this process is becoming more and more appreciated by welders as a reliable method of effecting repairs on cast iron. Unfortunately, it is not regarded as suitable for application to new castings, because of the colour.

CONCLUSION.

Salvaged Castings.

Following the presentation of his Paper, Mr. Steel showed some photographs of a number of cast-iron machinery parts and other structures which had broken and had been repaired by means of oxy-acetylene welding. One of the illustrations was that of the bedplate of a portable crane, which had been broken and had been repaired by welding at a cost amounting to about 25 per cent. of the cost which would have been incurred if it had been replaced instead of being welded. Mr Steel added that the average cost of repair by welding was about 25 per cent. of the cost of replacement.

He also illustrated an internal-combustion engine crank-case which had been cracked and repaired by welding. The whole job was preheated in a muffle, and when the welding was completed it was machined.

In another case, a large gear wheel, which had been cast in two halves, had cracked at a point where the rim met the end of one of the spokes, had been repaired satisfactorily, a preheating fire being lighted below it before and during welding. A fly press, which had been in service for ten years, after having been repaired by oxy-acetylene welding was also illustrated. The repair of a badly-broken air-compressor cylinder block, to which he drew particular attention, he regarded as a masterpiece. Again, a guillotine shearing machine, which had been broken at both ends within three days of having been put into service, had been repaired and had since been in service for twelve years.

The rebuilding of the valve seatings of a bilge pump by means of oxy-acetylene welding was illustrated, the seatings having been remachined after rebuilding. Mr. Steel added that he had seen the same thing done on cast steel satisfactorily by means of the electric-arc method, but he did not think the electric-arc method would have been successful on the cast-iron pump, because if the carbon arc had been used the seatings would have been too hard to machine, and the metallic arc would probably have produced blowholes.

£1,000,000 Loss to Foundry Industry.

Another exceptional job illustrated was the repair of a cracked cylinder in a motor-cylinder block by means of the oxy-acetylene process. In this case the wall of the water jacket had had to be cut away in order to get at the cylinder. Commenting upon this work, he said that perhaps the welder to some extent was taking the bread and butter out of the mouths of foundrymen, because a vast amount of welding in cast iron was being done satisfactorily, whereas, if it were not for the welder, the foundrymen would be engaged in replacing the broken castings. He knew one man engaged in welding who had an annual turnover of probably £2,000. If one reckoned the average cost of repair by welding as being 25 per cent. of the cost of replacement, it was apparent that that man was saving about £8,000-worth of castings in a year. If that figure were multiplied by 200 or 300, representing the number of people who were doing such welding work, it would appear that the sum saved annually as the result of welding was not far short of £1,000,000. Further, many welded machine parts and other structures were supplanting cast-iron castings.

In a reference to the cutting of cast iron by the oxy-acetylene process, he said that this material was much more difficult to cut than was steel, because there were more impurities in cast iron and it was difficult to combust the oxide. More oxygen was required, and a special type of preheating blowpipe was provided to give a greater supply of heating oxygen. Because the process occupied a longer time and because more oxygen was consumed, it was more costly to cut cast iron than to cut steel. He illustrated the cutting of a heavy cast-iron flywheel by the oxy-acetylene process, which had produced a very clean finished cut.

A practical demonstration of the oxy-acetylene welding of cast iron was then given by Mr. Gloss, a member of the staff of Messrs. British Oxygen Company, Limited, Angel Road, Edmonton.

Publications Received.

Petter Atomic Diesel Engine. — Messrs. Petters, Limited, Westland Works, Yeovil, have issued, in the form of an 8-page pamphlet, a Report of a Test carried out by Mr. W. A. Tookey, consulting engineer, on a twin-cylinder engine of 130 b.h.p.

Steam Separators. — Messrs. Warren Brothers (Middlesbrough), Limited, Prudential Buildings, Middlesbrough, have prepared a 28-page, well-illustrated brochure for describing Howard's patent steam separators. This has a fairly wide application, ranging from marine boilers to a steam whistle. With the brochure is enclosed a very imposing list of users.

Southampton Docks.—Published by the Southern Railway Company, Docks Managers' Office, Southampton. This interesting publication, which is available to our readers on application, contains within its 168 well-illustrated pages the rates, dues and charges payable by boats using the docks, together with a host of general information.

Book Review.

Swansea Royal Metal Exchange.—Forty-second Annual Report for the year 1928 to 1929. Price 3s. 6d.

This annual publication is of considerable interest to foundry owners as depicting the industries of South Wales. In this district the foundries are well organised through the Welsh Engineers' and Founders' Association and occupy an important position in the commercial and industrial life of South Wales. Its pages form quite a useful little directory of local industrial life.

Steam Nozzles Research Committee.—The sixth and final report of this Committee was submitted to a meeting of the Institution of Mechanical Engineers, held on February 21. The Committee was formed by the Council of the Institution in 1914 for the purpose of carrying out experimental work relating to the action of the steam passing through nozzles and steam turbines.

Foundry Training Abroad.

By J. G. Pearce, M.Sc. and M. H. Pearce, M.A.

II.—Germany *(continued)*.

The Kaiser-Wilhelm Institute for Iron Research.

In approaching the subject of this second article, it is necessary clearly to emphasise that it is of an entirely different nature from the German Technical High Schools as a whole, and consequently from the Aachen Technical High School, which has occupied the chief place in our previous consideration. Its influence upon foundry education and training, although highly significant, is of a completely different character. The Kaiser-Wilhelm Institute for Iron Research at Düsseldorf (Kaiser-Wilhelm Institut für Eisenforschung) is first and last a research institution. It was founded in 1917 as part outcome of a pre-war fund for research in applied science. The Institute was originally assisted financially by the State, but it is now wholly supported by the industry through the medium of a voluntary tax on output at the rate of one pfennig (0.1d.) per ton. A recent estimate of a very rough character suggested £40,000 as the annual upkeep cost of the institution, and, although this is in no way an official figure, it gives some idea of the magnitude of the undertaking. It is housed in buildings originally designed for the Rheinmetallfabrik. This fact is responsible for the arrangement of the various departments, which are scattered on the different floors of one large building, a state of affairs that is apparently felt to be unsatisfactory, so that, in fact, a transfer to more suitable and commodious premises is in contemplation. It must be said, however, that the building is spacious and convenient, and appears to the external observer to be eminently suited to its purpose.

In order to give the English reader some idea of the character of the Institute, it might not unfairly be described as a small and rigidly limited parallel to the National Physical Laboratory, or more accurately to one department of it, in so far as it is exclusively devoted to scientific research and fitted up to that end. In respect of its limitation and its constant efforts to present its results in a form accessible to the industry, as well as in its direct financial connection with the industry, it has points of resemblance to the Cast Iron Research Association. In the year 1927 the staff consisted of 95 persons, of whom 27 were college-trained. This will give some indication of the position that the Institute holds in respect of size, midway between the two British organisations named.

Organisation of the Institute.

The Institute is arranged in departments, including one devoted to administration, the various departments being, as already stated, scattered over a number of floors in one large building. The departments follow out the whole process of the ferrous industries. There is first of all an Ore Department, whose object is primarily to elaborate methods of treating and enriching low-grade iron ores, especially those in which Germany is rich. Then there is the Mechanical Testing Department, where the recognised methods of testing materials are critically examined, and special tests are elaborated to meet the definite requirements of special purposes. The main test room (Fig. 1) contains a number of strength-testing machines of various makes (Pohlmeyer, Losenhausen, Amsler, Krupp, Schopper), as well as impact test machines and apparatus for various other tests, including hardness-testing machines (Brinell, Rockwell and Shore). Special interest attaches to a Brinell machine enabling tests to be taken at elevated as well as ordinary temperatures. The Mechanical Engineering Department conducts research into the actual processes that are involved in the working of the material and the effect of these processes upon its properties, and pays particular attention to the mechanical process of deformation. It works in close conjunction with the Mechanical Testing Laboratory.

The Metallurgical Department includes a new melting shop, with a fine supply of apparatus for experimental work, including different varieties of furnaces, and among its activities a considerable number of tests have been carried out to determine the conditions necessary for the production of high-quality cast iron. The Physics Department works out and plots diagrams showing the effect of the most important alloy additions to cast iron, and carries out various kindred activities. The X-ray Department undertakes analytical work on crystal structures, and work on the changes that are due to cold deformation. There is an Electro-magnetic Department, containing apparatus for researches on alloys that possess special magnetic properties; a Metallography Department well supplied with metallurgical microscopes for micro-structural examinations as well as equipment for micro-photography; and an Optical Pyrometry Department. There is a Chemistry Department that attends to all the current analytical work in connection with the experimental materials in use in the various departments—iron, steel, metal alloys, ores, slag, etc.—and which also has small laboratories for the conduct of special researches.

Finally, there is a workshop to which rather special importance is attached, since it prepares the test-pieces required for the research work in the different departments, and, in addition, makes and repairs apparatus and attends to fitting work. It is well supplied with the requisite machinery, and it is considered in the highest degree desirable that all work of this kind should be attended to as and when required on the premises. The absence of a large-scale melting plant is overcome by access to the furnaces and plant of the adjacent Rheinmetallfabrik.

The Work of the Institute.

Writing not long ago of the Institute's work, Prof. F. Körber, its director, said: *"The Institute is equipped with the essential apparatus, etc., required for fulfilling its main function, which is that of affording the necessary scientific basis for methods of producing and working iron and steel." The Institute thus covers both iron and steel. In addition to the purely scientific work, for which it was primarily founded, the Institute undertakes research of a more particularised character on subjects that are of vital practical importance to the industry.

The Educational Influence of the Institute.

At first sight, while the research possibilities of such an institution may be conceded readily enough, its educational aspect must be somewhat less easy to determine. It must be borne in mind here that education is not after all solely a matter of teaching students in classes, and that, in a sense, such teaching is of an essentially preparatory character. In Germany, where this more obvious aspect of technical teaching is dealt with by the Technical High Schools, which we have already considered at some length, there is a very definite place for the educational influence of such a specialised research institution as the Kaiser-Wilhelm Institute at Düsseldorf.

This educational influence is disseminated in two ways. The first is by the obvious and direct method of publishing as many as possible of the results obtained, particularly in the special researches referred to, not only in suitable technical publications but also in the Institute's own journal.† The extent of these publications may be gauged by the fact that 91 Papers were published in these collected research reports over the period 1920-27. Great importance is attached by the authorities of the Institute to this process of the publication of results, and this fact in itself is a further indication that their influence is felt to be desirable.

The second method is through the personnel. It must be reiterated here that the technically-trained man has a much more definite and accepted place in industry in Germany than is yet allotted to him in Great Britain, and that men of this type are employed in the regular course of events in very many foundries. From this it results not merely that there is close understanding and co-operation, as well as considerable mobility, between the research men and the actual employees of industry, but—and this has a bearing upon the previous point—scientific developments find their way readily and naturally into industrial practice. The work of such an institution as this, therefore, is definitely educational as far as the technical grades of industry are concerned.

As must be the case in all research institutions, the influence of the Düsseldorf Institute is closely bound up with the influence and the prestige of its staff. The Director, Prof. F. Körber, is chiefly known for his work on steel and the effects of cold work and deformation, as well as for his work on cast steel. Dr. P. Bardenheuer has published studies on graphite in grey iron, powdered fuel for the cupola, high-quality grey irons, the shrinkage of grey iron, oxygen and hydrogen in iron, and semi-steel. Dr. Körber's predecessor was the distinguished metallurgist Herr Geheimrat Wüst, whose most recent contribution to foundry studies is a combined cupola and oil-fired furnace for high-quality irons.

* "Stahl und Eisen," 1927. No. 42.

† "Mitteilingen aus dem Kaiser-Wilhelm Institut für Eisenforschung."

Continental Steel Cartels.

The managing committee of the Continental Steel Cartel has decided that production in March shall be maintained at the same rate as in February. At the Paris meeting on February 28 the proposed agreement in regard to the selling syndicates received further consideration, and this matter will again be discussed at a further meeting on March 13 and 14, probably also in Paris. The quotas of the national groups have not yet been fixed, slight differences still existing as to the treatment of French exports of semi-finished steel to Belgium. An extension of the selling syndicates has been effected by the decision of the Belgian rolling mills to associate themselves with the selling syndicates, they having now come to an agreement with the Belgian producers of semi-products in the matter.

Wire Rod Syndicate.

The International Wire Rod Syndicate, at a meeting held in Paris last week, decided to increase the production programme for the second quarter. Prices have been left without change at between £6 5s. and £6 10s. for the sizes of between 5 mm. and 13 mm. A decision has not been reached in regard to the fixing of export prices for the Scandinavian and Japanese markets, as the question is considered to be not yet ripe for settlement. The definite inclusion of the Central European group is expected to be decided one way or another in about a week's time.

The Tube Syndicate.

The German Tube Syndicate has issued a denial of the report emanating from merchant circles to the effect that the International Tube Syndicate has reduced the prices of gas and boiler tubes by from 3 to 4 per cent. for certain districts. On the contrary, the International Syndicate, it is said, has lowered the discounts for certain markets. It is added that there has been a slight improvement in the export demand.

XUM

Increasing Foundry Production with Existing Box Plant.

Mr. J. Deschamps, of Messrs. Kryn & Lahy, Limited, Letchworth, has brought to our notice a patented method of increasing foundry production on certain lines of castings. He is prepared to give further particulars on behalf of the inventor, Mr. Libois, to any of our readers. The invention relates to a process for the moulding of castings in any metal, intended to be used more particularly in pattern-plate moulding. The methods actually employed in foundries for making sand-moulded castings necessitates the use of a large number of moulding boxes of all sizes. Each casting to be made is moulded separately and requires the use of one or several snap flasks or boxes. Because of this, there is in a foundry the necessity of having a very large number of these boxes and of using a sometimes considerable area for their storage.

The invention aims at permitting the manufacture in one box of twice as many moulds from the patterns mounted on a pattern plate,

Fig. 1.

and consequently allowing, with the existing plant, the halving of the number of reserve boxes, or, with the aid of boxes in stock, the doubling of the production.

With this end in view, the process is characterised by sticking together two identical cores at their base and placing them in the interior of the two enclosing boxes, which have previously been prepared with the aid of a pattern plate.

In the practical carrying out of the invention, two cores are made in the usual way in a core box and two boxes are prepared in sand from a pattern plate, but instead of then placing a core in each of the two boxes and placing them side

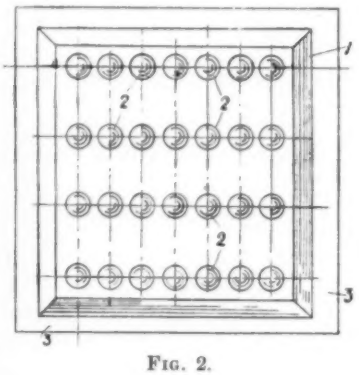


Fig. 2.

by side to obtain the castings by a common runner, the two cores are stuck together at their base, and are then placed in the interior of the two boxes, of which one has been placed on top of the other, after having been turned over.

The castings are cast in this way symmetrically in relation to the joint line of the boxes, by the runners provided in the usual way in the upper moulding box.

In order better to understand the invention, a practical example is outlined below.

Fig. 1 shows a pattern plate in section made by the plane 1—1 of Fig. 2, which is the plan of Fig. 1. Fig. 3 shows the plan of the box prepared with the pattern plate. Fig. 4 represents the vertical section of a core box, and Fig. 5 the vertical section by the plane V-V of Fig. 3, the position of the cores in the two enclosing boxes. Fig. 6 is the vertical section made by the plane VI-VI of Fig. 3.

The example demonstrates how balls in any metal may be made. The pattern plate, 1 (Figs. 1 and 2) presents, in this case, hemispheres, 2, which are arranged in four rows and surrounded in the usual way by a horizontal part, 3, meant to receive the box, 4, which is then rammed with sand. After this ramming operation, this box, 4, is lifted by its lugs, 5, and the runners, 6, are cut in the sand to allow the metal to flow into the hemispherical sand moulds. This operation is repeated a second time in order to obtain a second and identical

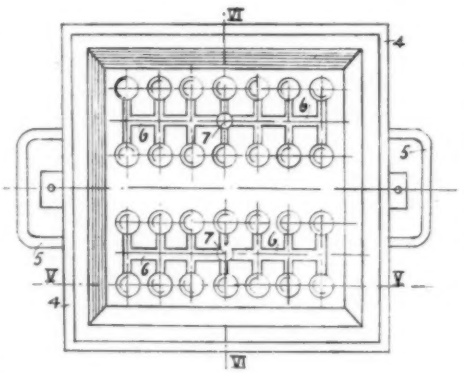


Fig. 3.

box, but in which, however, the runners, 7, have been made.

Meanwhile, a core box, 8 (Fig. 4), which presents equally hemispheres, 9, is elsewhere filled with core sand, which, after having been rammed up, is withdrawn in the usual way and forms the core, 10. A second core, 11, identical with the first, is next made, and these two cores are then stuck together by their base, 12, in such a way as to form the double core shown in Figs. 5 and 6. This double core is finally pierced with runners, 13, which correspond to the runners, 7, of the second box.

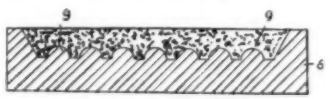


Fig. 4.

The different preliminary operations being finished, one proceeds in the following manner:—The first box possessing no runners receives the double core, which is so placed to present the joint level of the bases, 12, to the level of the box. The second box is then placed on the first, after having been turned over in such a way that the channelling made by the pattern plate corresponds perfectly to the part of the core protruding above the plane of the joint, 12. The

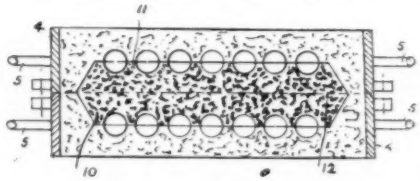


Fig. 5.

two boxes are next fastened to each other in the usual way, and the casting of the metal is effected through the runners, 7. The molten metal flows through the runners, 13, and the gates, 6, into the spherical moulds formed by the joining of the hollow hemispheres of the boxes and cores.

It is evident that the invention is not limited to the example described above, but that it applies equally to the moulding of all castings which may be obtained by the use of pattern plates and cores.

This method ensures a saving of 50 per cent. on the cost price as well as an appreciable reduc-

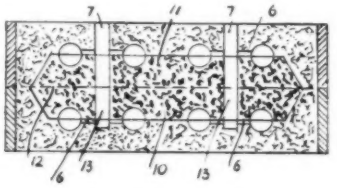


Fig. 6.

tion of the time in casting and stripping. Another advantage is the distinct economy in sand.

This process equally allows a noticeable reduction of equipment, in that one can double, and eventually quadruple, the number of castings by boxes, and that for the same production one need use only a quarter or half of the boxes which are actually necessary in the methods normally used. Finally, for the same production, it is only necessary to use a half or even a quarter of the space normally required.

A Catalogue of American Industry Sent to Russia.

A catalogue of American industry and trade, containing 1,000 pages and indexing 6,500 companies manufacturing equipment of interest to Russia, has been published in the United States by the Amtorg Trading Corporation, New York, and 10,000 copies have been shipped for distribution throughout the Soviet Union. In a foreword, Saul G. Bron, chairman of the board of the Amtorg Trading Corporation, writes that at the present time, the penetration of American technique into Soviet industry, and partly into agriculture, is proceeding at a fast rate. This is evident from the fact that, of the 30 technical-assistance contracts with American companies at present in operation, over half have been concluded within the last six months.

It is further pointed out that in the six years of trade between the Soviet Union and the United States the turnover has been $580,000,000 (slightly under £120,000,000), of which purchases of American products totalled $450,000,000 and sales in the United States $130,000,000, an adverse trade balance for the U.S.S.R. of $320,000,000. The United States, says the foreword, is the only important country with which the Soviet Union has an adverse trade balance.

Vanadium in Steel.—At the annual meeting of the American Society of Mechanical Engineers recently held in New York, Major G. L. Norris contributed some notes on vanadium steels, in the course of which he said that vanadium is used in 90 per cent. of the alloy-steel locomotive forgings and castings, not to deoxidise the metal (as has often been stated), but for its alloying qualities after the deoxidation has been accomplished by cheaper and more powerful deoxidising elements, such as silicon and aluminium. It imparts fine grain-size and improved strength. Steels containing vanadium in appreciable amounts, sometimes even as low as 0.05 per cent., show less dendritic segregation than do vanadium-free steels.

XUM

A Review of Modern Cupola Practice.*

By H. W. Keeble.

The foundry cupola constitutes an economical and convenient form of melting for the production of fluid iron for castings. Owing to widely divergent conditions under which cupolas may have to work, hard-and-fast rules relative to the procedure to be followed are not feasible. Each furnace requires individual scientific study, for maximum output with minimum production costs. The first section of this Paper deals with the principles of design for general practice and the second with practical cupola operation.

Cupola Design.

The design and proportions of a cupola primarily controls the efficiency and method of working a melt. The straight-line shaft cupola finds universal application. A high cupola from hearth to charging door melts more iron in a given time with less fuel than a low one of the same internal diameter, as the heat of the ascending gases is utilised to pre-heat the charges. The correct height from the top of the tuyeres to the charging door is a function of the internal diameter at the tuyere level, and is given by the equation H (height) = 20 to 24 $\sqrt{D}$, where D is in inches. The height of a cupola is also limited by the crushing strength of the coke, and cost of hoisting the stock to the charging platform.

The lining is built of firebricks. The joints should be made as small and tight as possible, as it is here that the lining commences to fail. A good jointing consists of equal parts of ganister fireclay, and crushed silica brick made plastic with water. Angle irons placed at intervals of about 3 ft. up the shaft enable parts of the lining to be renewed without disturbing the remainder. Linings should be 4 in. to 5 in. thick for small cupolas, and 6 in. to 9 in. thick for the larger sizes. With every-day use, a lining of average quality will last at least six months before renewal is necessary. Rammed or monolithic linings are finding increasing use, and undoubtedly, if rammed, vented and dried properly, they possess the advantage of lower initial cost and larger working life over that of a brick lining.

Air Supply Details.

The distance from the hearth to the tuyeres is determined by the duration of the melt, and the amount of iron required at each tap. Low tuyeres allow economy in bed coke, and small quantities of metal at a tap with a high degree of super-heat, as the iron has only just passed through the melting zone. High tuyeres need increased bed coke, but larger amounts of metal can be had at each tap. In practice the height of the tuyeres from the hearth is varied (within the above considerations) from 12 in. to 26 in. The tuyeres should be rectangular, flared out at the internal end, and regularly spaced around the cupola, so as to form a practically continuous belt of air entering the furnace. Small tuyeres tend to oxidise the metal and cause "spotty" burning of the coke. On 30-in. cupolas the total tuyere area (measured at the external end) should be a quarter, and on large cupolas (48-in. dia. and over) should be one-seventh of the cross-sectional area of the melting zone. One row of tuyeres saves the bed coke, but two rows will melt faster, with a corresponding increase in fuel, and will produce very hot metal owing to a deeper melting zone. The second row of tuyeres is generally about 10 in. to 12 in. above the first row (measured from tuyere centres). With regard to the second row of tuyeres, care must be taken to ensure that its distance above the first row is such that it does not introduce the formation of a second melting zone, which, from the view of economy and regularity of melting, is to be avoided. All tuyeres should be fitted with valves to cut off the blast in case of bridging. They should not project into the cupolas past the lining, as they form shoulders whereon slag may settle and build up a scaffold.

The blast belt should be of such a size to pass on with minimum resistance to the tuyeres, the air from the blower or fan, and neutralise any pulsation due to the blowing apparatus. Means should be provided for cleaning out the blast belt, as frequently pieces of coke, etc., may fall in through the tuyeres resulting from the crushing action of the stock. The air-supply pipe should enter the blast belt at a tangent, facilitating regular distribution around the wind belt. The blast main should be free from twists and bends, and the source of the air supply as near to the furnace as reasonably possible. Turbo blowers, combining the principles of the fan and positive blower, generally constitute the air-supply plant.

Volume and Pressure of the Blast.

For maximum heat at the melting zone the carbon and air must be burnt to carbon dioxide. Unless the coke and air introduced into the cupola are in correct proportion for production of CO_2, maximum heat is not developed. Volume, not pressure, is of primary importance in controlling the CO_2 reaction.

The function of the pressure is to ensure penetration of the blast volume to the centre of the furnace and up through the stock, and the minimum pressure should be employed to accomplish this. A hard blast tends to promote oxidisation of the metal, and a soft blast tends to rise around the furnace lining. Blast pressures vary, according to the size of the cupola, over a range of 4 to 16 ozs. per sq. in. All cupolas should be fitted with volume- and pressure-recording instruments.

To burn 1 lb. of coke, containing 10 per cent. ash and moisture, to carbon-dioxide, 137 cub. ft. of air is required. Assuming 1 lb. of coke melts 10 lbs. of iron, 30,600 cub. ft. of air are required per ton of metal melted. This ratio of 1 to 10 may be considered good practice, but it depends and varies on the character and size of the charge components, and casting requirements. For instance, when melting heavy machinery cast-iron scrap and steel scrap, it is necessary to use more fuel, thus raising the coke to iron ratio. 1 to 7 or 8 would be a normal ratio when working under these conditions. Thus the air requirements should be calculated on the coke to iron ratio. Whilst discussing these ratios, it must be remembered that the term melting not only implies a rendering to the liquid condition, but a liquid state with a fair degree of superheat necessary for pouring good castings.

Cupolas with Receivers.

Cupolas may be operated with receivers to advantage according to the type of castings being produced. Its object is to store the molten metal, leaving the cupola free as a melting unit only. The height of the tuyeres from the hearth may be reduced to a minimum requiring less bed coke, also reducing carbon and sulphur pick-up from the fuel. The risk of slag rising and flowing into the tuyeres is eliminated, as all slagging is carried in the receiver and the furnace is kept cleaner. Also, it aids the mixing of the charge components into a homogeneous whole. A receiver has the disadvantage of cooling down the first metal, increases the difficulty of charge separation and incurs higher maintenance costs.

Practical Cupola Operation.

An examination of the condition of the interior of the cupola and the constituents of the drop after a previous "blow" will to the observant eye supply many points for consideration as to whether the cupola is being efficiently and economically operated. The drop should be inspected, and the coke and iron separated and weighed. The coke can be used for the core stoves and the iron returned to the charging platform. The melting rate should be estimated on the metal charged minus the drop. Iron in the slag denotes that a careless tender has allowed the metal to flow out with the slag from the slag spout. The slag spout should not be used as a gauge of the metal level in the hearth.

Unless the drop has been very heavy masses of slag will be seen adhering to the lining just above the tuyeres. This is generally greater on boshed cupolas. Exceptionally large masses forming a bridge persisting after each blow, indicates that the slag is pasty, and easily chilled, thus requiring more flux to promote fluidity. These masses of slag should be carefully chipped out, avoiding damaging or pulling out parts of the lining. A clean background is essential if the patching material applied is to adhere properly. Daubing placed on the lining over films of slag will fall away and expose the weak places to erosion by the charges on the generation of heat by causing the slag to melt. Scouring above the tuyeres indicates the position and extent of the melting zone, which should be clearly defined. It is in this zone that the maximum temperature is developed, and the iron melted and superheated. The melting zone should be a defined scoured belt in the lining extending to about 20 in. from the top tuyere level. When this melting zone is imperfectly defined it is indicative of an excessively high and fluctuating bed, caused by variations in the weight of coke introduced per charge of metal. A melting zone which is uneven horizontally with irregular scouring may be due to blocked or badly-spaced tuyeres, irregular distribution of air in the blast belt, resulting in lack of air at one side, or non-uniform charging of the fuel and flux over the stock. Changing the volume of air supplied during a "blow" alters the position of the melting zone, and so for uniform melting conditions the blast volume should be kept constant.

There are two points to bear in mind concerning the patching material and its application. They are:—(1) The patched lining must be resistant to abrasion by the descending stock and the chemical action of the heat and slag, and (2) the daubing should just replace the lining that is worn and burnt away each day. Any excess lessens the effective diameter of the cupola.

The material should be highly refractory and sufficiently plastic so that on its application by throwing on the walls of the lining it penetrates into the cracks and crevices, and thus secures a good hold. Moulding sands do not usually possess the degree of refractoriness necessary for this particular purpose. River sands are generally too high in lime. Good Sheffield ganister, ground and made into a stiff paste with water, is quite satisfactory. The daubing should be used in as stiff a condition as consistent with plasticity. The lining is damped down with clay wash, any large holes plugged up with broken firebrick, and the patching material applied. It can be roughened into the shape of the lining contour by a trowel. A slick wet finish is undesirable, as it necessitates the use of excessive water, which, on evaporation, is liable to cause the patching to peel. The thickness of the daubing at the melting zone should be about 1 in. thick, running off to a bevelled edge as the melting zone ends.

Making the Hearth.

The bottom doors are then raised and keyed into position. Frequently a steel or cast-iron

* A Paper read before the London Junior Section of the Institute of British Foundrymen, Miss M. D. Pittuck presiding.

prop is used to make the doors firmly secure. Where the external supports are used, it is best to let them rest on a steel or iron plate, ensuring no "slip" or "give" of the hearth as the cupola is charged. Making up the sand hearth requires the exercise of considerable care. New sand or fireclay should not be used on account of the high clay content, which, on drying, sets hard, and difficulty is experienced in obtaining an easy and clean drop. The sand should be preferably tough, fairly open, and rammed carefully, and not too hard to a minimum depth of about 4 in. Riddled foundry black floor sand alone, or mixed with one-third of new sand, has proved eminently suitable. The sand for the best results should be on the dry side, as, if wet, it is liable to cause the metal to "boil," effecting a leak or yielding dull iron at the first tap. The hearth should have a direct slope to the metal tap hole, avoiding saucer or hollow shapes, as these facilitate burning through. At the periphery the hearth should sweep up to the lining, with a fairly large radius forming a fillet.

Construction of the Tap Hole.

Construction of the tap hole is decided by the particular arrangement of the cupola. In some furnaces the tapping spout is embodied in a breast or hole, which is closed by a breast-plate after the cupola is lit. In modern cupolas the metal spout opening is situated opposite the breast hole, is small, and formed by ramming a mixture of fireclay and sand around a tapered plug in an opening of the brickwork. The tap hole has an external diameter of 2 in. to 3 in., tapering to ¾ in. on the inside. A quantity of plumbago mixed in with the fireclay militates against the iron and slag sticking in the tap hole. When the blast is put on, the tap hole is left open, and the flames issuing dry and burn the clay to a degree of hardness sufficient to withstand the wash of the metal and the prodding of the tapping bar. Special tap-hole bricks are manufactured, and these can be built into the furnace to form a permanent metal notch. Tap holes in receivers are necessarily of a temporary type, as they have to be destroyed after each blow in opening the breast to remove the slag and making up the new hearth for the next melt.

The tapping trough should be lined with a good loam sand, rammed and moulded into shape. it should be given a coating of black wash and dried by a fuel-oil torch or a wood fire along its length. The trough should have a gentle slope from the furnace and projections or hollows wherein the metal may lie be absent. The best shape of the section of the trough is debatable, a "U" shape has, however, been found satisfactory.

With the completion of these operations the cupola is ready to be lighted and charged. Pieces of wood are placed on the hearth through the breast hole in a lattice formation, and some pieces placed upright around the lining so as to protect the lining whilst drying. A skein of ignited cotton waste soaked in paraffin is introduced through the breast, and the wood fired. All tuyeres are opened to create a natural draught.

Bed Coke.

The quality of the bed coke, its amount, and method of charging, predetermines the success or failure of a melt, and is one of the primary factors in obtaining hot metal initially. The coke should be hard and dense, possessing a grey metallic lustre, and resist the crushing action of the burden. It will consist of about 90 per cent. of carbon and the sulphur content must not exceed 1 per cent., the remainder being ash and moisture. The bed coke should be in as large and even-sized pieces as possible, and a few forkfuls introduced on to the burning wood.

The breast hole is now made up. A wall of coke is made in the breast-hole opening and the outside surface moistened with clay wash, and covered with foundry black floor sand. The breast plate is now lifted into position and secured by a curved bar and wedges. This wedging forces the sand against the coke wall, making a secure joint. By this time the first coke charged has burned through, and if pink and even—not white on one side and black on the other—the remainder of the bed coke is added. If the rate of ignition is too slow for some specific reason, the blower may be switched on with the rheostat or blast gate nearly closed. The proper height of the bed coke above the tuyeres depends on a number of factors; usually it is about 24 in. as measured by a rod let down from the charging door. Some cokes crush down more than others, therefore demanding a higher bed. The greater the height of the charging door above the tuyers, the greater the crushing force. High blast pressures raise the position of the melting zone, increasing the proper height of the bed. Usually the best method of obtaining the correct height is the experimental one. First employ an excessive height and notice condition and time taken for the first metal to appear at the tapping hole. The bed can then be reduced gradually until the iron appears in a reasonably fluid condition about 10 min. after putting on the blast. The bed coke should always be measured by height, and the coke splits between the charges by weight. Another factor helping to ensure hot metal from the start is to charge the stock and allow the furnace to "soak" for an hour before putting on the blast. The percolation of the hot gases rising from the bed coke preheats the charges and warms the hearth and lining.

Necessity of Weighing the Charges.

The weight of the iron charges in normal practice varies according to the size of the cupola. On a cupola with a melting rate of 4 to 5 tons per hour 8 to 10 cwt. charges may be safely used. The charge consists of all or some of the following materials, charged in various proportions to each other, according to their analysis, and that desired in the final iron:—Pig-iron; returned foundry scrap (comprising runners, risers, feeding heads and wasters); heavy cast-iron scrap; and steel scrap.

It is definitely necessary that a weighing machine should be used in making up the various charges. Dumping pig-iron and scrap with coke and limestone into the cupola irrespective of proportion, quality and analysis will inevitably yield erratic results, besides inducing high production costs. For regular and economical melting, the materials of the stock must be balanced, so that there is sufficient flux to form a liquid desulphurising slag, and enough coke to maintain the position of the melting zone with maximum heat. Extremes in the percentage of individual constituents of the charge components should be avoided, as they favour the production of a metal non-uniform in composition. For instance, if a hematite pig-iron or steel scrap, containing 0.05 per cent. phosphorus, be charged with a pig-iron containing 1 per cent. of this element, a wide variation exists, which, if careful charging and regular melting conditions are not practised, will appear in the final metal. High scrap percentages are dangerous if the sulphur content of the final iron is not controlled. It is advisable, where considerable quantities of returned foundry scrap are used, to employ a high-manganese pig-iron in the mixture. This will balance the sulphur tendencies. Steel scrap is used on account of its effect of closing the grain of the metal. In ordinary metal percentages up to 25 per cent. are used.

Charging the Cupola.

When charging the furnace, the stock should be introduced in the same order each time; also, as far as possible, the components of the mixture should be of uniform size. The pig-iron should be in pieces of about 1 ft. long, and placed flat around the edges. If dropped endwise, it digs into the bed and sinks below the melting zone, and has to be melted by the molten iron falling from above, yielding dull iron at the metal spout. The heavy scrap is next charged in like manner, and the lighter scrap is placed in the centre. Where very large lumps are to be used, these should be placed in the centre and surrounded by smaller material. Thin scrap tends to oxidise readily, so flashings or extremely light scrap should be used with care. If rusty or dirty scrap is employed, extra flux must be used to take care of the impurities. If steel is used, it should be placed on first, evenly distributed, so as to be melted first and attain equilibrium as regards the carbon absorption at the furnace temperature.

The coke-splits between the charges are for the purpose of replacing the amount used from the bed in melting the preceding charge. It has been found that the bed coke is lowered about 4 in. per charge melted. A rough guide to the weight of coke needed can, therefore, be obtained by filling a ring of the diameter the same as the cupola about 5 in. to 6 in. deep, allowing for the crushing action of the stock, and weighing this volume. The correct weight of the coke to be added per metal charge for any particular cupola must vary with local conditions, and can only be found experimentally.

The cupola is charged up to the charging door, and is now ready for a melt. The blower is started and run at full volume from the commencement. With proper conditions, globules of metal will be observed through the tuyeres in about 5 min. After about 10 min. from the start, metal will appear at the metal spout. About 1 cwt. is run out, and then the tap hole is botted-in, and the iron allowed to collect in the hearth. The time taken for its arrival and the condition of the metal at the tapping spout is indicative of whether the correct height of bed coke is being employed. If the time is greater than 12 min., the bed is too high; if the iron appears in less time and is comparatively dull, the bed coke is too low.

Fluxing.

Flux is added to the stock, and the amount required will vary according to the amount of silicons, dirt and rust charged with the iron, and the percentage of coke ash. The usual flux is limestone consisting of not less than 95 per cent. calcium carbonate. It should be regular in size, and containing a minimum of "fines," as these are often contaminated with clay and sand. A good quantity for general purposes is 30 per cent. by weight of the coke charge. With this amount and the cupola working efficiently, a slag of the following approximate analysis will be formed: Silica, 50 per cent.; lime, 27 per cent.; ferrous oxide, 12 per cent.; alumina, 6 per cent., and manganese oxide, 5 per cent.

Excess flux attacks the lining, and just enough should be added to form a fluid slag at the slag notch. Slagging should be carried out periodically during a blow, although on long all-day melts. The slag-hole is frequently kept permanently open, as continually opening and shutting it alters the position of the melting zone. The slag spout is best situated about 6 in. below the lower edge of the blast belt, midway between two tuyeres.

As the metal is melted and tapped out there are one or two points to remember to practise for efficient working. Run out as many charges at once as possible; never tap for half a charge. Where "shanking" is employed and there is no receiver, tap the whole into a ladle and then into shanks. Tapping about 1 cwt. for every shank is decidedly bad practice, as little chance is given for mixing. A pointed steel rod is used for tapping, and if twisted in the hole will remove all frozen drops of iron and slag which block it. An applied knowledge of the melting rate is necessary so that careful timing of the charges for tapping out may be practised.

Separation of Charges.

Where two or more mixtures are being melted during a "blow" difficulty may be experienced

in obtaining separation of these irons at the metal spout. This difficulty may be minimised by introducing an extra coke charge between the mixtures. The coke will temporarily hold up the melting by being burned itself, and the preceding metal may be run out before the second mixture is melted. Where large tonnages are being melted the change from one mixture to another may be accomplished by two neutral or transition charges, gradually working to the composition desired in the special mixture. The transition charges may be used for pouring unimportant castings and the third iron charge may be of the special iron, and the metal may be relied on to be that of the required analysis. Where the extra coke charge is used, it has been experienced that the second iron possesses a higher total-carbon content, evidently due to absorption from the extra coke.

When a "blow" is nearing completion and the stock is at a white heat the blast may be cut off, as it is liable at this stage to effect considerable scouring of the lining. All the metal is tapped out and the metal spout botted in. The bottom doors are opened, the breast broken through and the stock dropped. The drop is raked over and damped down so that it does not cool into a solid mass of coke, iron and slag. The drop is not withdrawn from under the furnace, as the heat ascending from it allows the lining to contract gradually, without undue risks of cracks or distortion.

Working Troubles.

There are one or two troubles which are liable to occur whilst working a blow, and their cause and remedy will be briefly enumerated:—Scaffolding is a frequent trouble and may be caused by irregular sizes of charge components, viscous and pasty slag being cooled by the blast and bad fettling of the furnace lining after a previous melt. These causes can be remedied by poking with a bar from the charging door, or through the tuyeres, or coal introduced into the cupola hearth will generally melt out the obstruction. Also the tuyeres, above which is the scaffold, should be temporarily shut. Leaks of the metal through the hearth may be due to wet sand, saucer-shaped or too hard-rammed hearth, and faulty rigging of the bottom doors. When a leak occurs, all the metal should be immediately tapped out and the blast cut off. The little metal and slag, which will trickle down, will, if the leak is small, form on cooling, an effective paste with the sand and thus seal the leak. If this is not successful, the breast must be opened, new sand introduced into the hearth and the breast rebuilt. Bursting of the tap hole is generally due to the use of unsuitable material, that is, it contains a low clay content or has no effectual bond. Causes of dull iron have been considered in discussing the fuel bed and coke charges. Oxidised iron is due to a hard blast through small tuyeres or the use of rusty scrap with no extra flux.

Finally, it is well to bear in mind that whilst slovenly and unscientific practice may serve for a short melt, the same practice applied to continuous melting will speedily culminate in disaster.

Overoxidation in Open-Hearth Process.—According to Mr. Alexander L. Feild (in Technical Publication No. 280 of the American Institute of Mining and Metallurgical Engineers), overoxidation of the metal bath during refining by the basic open-hearth process is an inherent feature. It may be reduced to a minimum only by obtaining a relatively slow rate of carbon drop and by the maintenance of a slag as low as practicable in effective FeO content. Sufficient data are not available to determine whether or not a heat is in better condition with respect to FeO during a very slow boil than it is after it has come to practical equilibrium under the "flat" slag which characterises completion of the boil, carbon content, FeO content of slag, and temperature being the same in both cases.

The Copper Situation.

From a Correspondent.

The copper situation appears in many ways to be approaching a deadlock, for on one hand is the Association of American Producers resisting all efforts to effect a break in the 18-cent level which has now obtained since last April, while on the other are the world's consumers helpless against the machinations of this all-powerful ring. Europe has learned since the war that humbug is not only confined to the Old World, for the spectacle of the United States, self-advertised as an anti-trust country, countenancing, and even encouraging, such a body as Copper Exporters Incorporated, can only be regarded as farcical.

For months past the market has taken the view that the present price of copper is too high, a fact most unmistakably registered in the quotation for standard copper, which has varied between £15 and £16 below electrolytic, while consumers have stubbornly clung to their policy of hand-to-mouth buying. This in itself does not matter much, for whether buyers cover for two or three months ahead or take supplies into their works week by week, the sum total over a period is the same, and reference to our imports of copper for last year show that if our consumption was not greater than in 1928, we did at any rate receive more copper from abroad. During the period that this hand-to-mouth practice has been in vogue stocks of refined copper in the producers' hands have increased by leaps and bounds, till at December 31 last the total stood at 171,000 short tons; but it may be reckoned that manufacturers are carrying much less metal, and, although warehouse stocks have increased on this side, they are far from adequate.

Nevertheless, the fact that electrolytic copper is available in moderate quantities in this country is interesting, for it has always been the avowed policy of the exporters to ship copper only against orders and not to allow parcels to come across on the off-chance of finding a customer on arrival. In view of the heavy stocks in America, it is not unlikely that the producers have felt inclined to waive their insistence on this ruling, and it will not be surprising if the amount of copper in this country available for prompt sale shows a still further increase. After all, since buyers here appear definitely to be wedded to the hand-to-mouth policy, it is surely a good plan for the sales organisation to play up to this fad by keeping material on hand for them. At the present time it is likely that this prompt material is rather hanging fire, for undoubtedly outsiders are competing keenly with the American ring and securing a good deal of the business offered. Another factor telling against the exporters, whose control is only exercised over electrolytic brands, is the growing preference of manufacturers for fire-refined brands which are of first-rate quality and usually obtainable at £3 or £4 per ton below the controlled quotation for electro. Such copper is, of course, unsuitable for the electrical trades, but here, again, the Combine is missing direct sales of wire bars, for wire-drawers are purchasing imported rods at a fraction above the cost of bars.

The producers of copper, realising that the tide is setting against them, have now announced their intention of curtailing output to the extent of 30 per cent., and steps towards this end have already been undertaken. The somewhat extraordinary action of closing down low-cost properties and maintaining the output of high-cost mines has, however, been taken, which is in itself surely sufficient indication that the whole position is fictitious and that mine-owners intend to reap all the benefit they can while the umbrella of inflated values is held over them, reserving their cheap production areas for the day when the inevitable fall in price takes place. Very plausible arguments in defence of an 18-cent price level have been advanced, the contention being that copper is valued very little above its pre-war level, but costs of production have come down with a run during the past twenty years and are well below what they were before the war. Dividend-earning power is, therefore, unimpaired and actually improved, and it would be interesting to know what shareholders think of the decision to curtail production in such a drastic fashion.

Last Year's Repercussion.

The copper fiasco last year, when prices were pushed up to an undreamt of level, only to fall again with unwholesome speed, has left the position very unstable and consumers in a state of nerves from which they will take some time to recover. At the present time their great fear is of a fall in the price, and, not unnaturally, schemes involving an extensive use of copper are being shelved pending this long-expected drop to a more reasonable level; in the meanwhile aluminium and other metals are coming into their own in competition with the red metal. A stock argument of the producers of copper against lowering the price of their product is that sales would not go up as a result, but this is undoubtedly a fallacy, as in due course the Copper Combine will find to its cost.

At the moment various factors are at work to check consumption of copper, and until the upset created by the Wall Street slump and uncertainties on our own stock market have subsided it is useless to expect any expansion of business. Misled by this absence of life in the situation, the copper control trembles at the thought of taking the very step which would best combat the apathetic attitude of consumers and flies to the desperate expedient of curtailing production. By so doing they may temporarily maintain their price, but when the bubble of this inflation is pricked the Exporters' Association is likely to vanish with it.

Catalogue Received.

Welding Cast Iron.—The Suffolk Iron Foundry (1920), Limited, Gipping Works, Stowmarket, has sent us a copy of the 5th edition of their catalogue, outlining the potentialities of their brands of welding rods and fluxes. This edition contains 52 well-illustrated pages, of which 12 deal with new matter. We would suggest that the time has now arrived for the incorporation of a contents, as catalogues are primarily works of reference and not text-books. Actually, however, this pamphlet under review serves the dual purpose. An indication of its comprehensiveness is shown by scanning a few of the captions, which include Acetylene Apparatus, Blowpipes, Correct Flame, Properties of Cast Iron, Eliminating the Scrap Heap, Preventing Costly Stoppages, Preparation of the Casting, Expansion and Contraction, Welding Rods, Preliminary Tests for Cast-iron Rods, Methods of Welding, Thin Sections, Repairing Cast-iron Spur Wheel; Hints to Oxy-acetylene Welders, "Sifbronze," Oxy-coal-gas Welding, Hints on Using Sifbronze Rods and Useful Data. Unquestionably, this is a useful little book, and as it has reached its 5th edition, we suggest that for the sixth the following details might usefully be emended. The section on welding malleable iron requires to be re-written to take cognisance of black-heart malleable; attention should be paid to the formulæ for the elements such as S instead of Su and Mn instead of M; and Figs. 10 and 11 could be deleted without detracting from the usefulness of the book. Uniformity in the method of expressing temperature is also another suggested improvement, preferably using the Centigrade scale. Beyond the minor criticisms, we have nothing but praise, and strongly recommend our readers to procure and file a copy of this book for future reference.

Beryllium.

We have received from Messrs. Louis Hamburger & Company, 5, Meineke Strasse, Berlin, W.15, a four-page leaflet which summarises the properties of the metal beryllium and some of its alloys. From it we have made the following abstract:—

The weight of beryllium is only 65 per cent. that of aluminium (S.G. of Be 1.85, and of Al 2.7). It is exceedingly hard, being able to cut glass, and is also very brittle. The melting point is 1,278 deg. C. (Al 658 deg. C.). Beryllium for technical purposes has a metallic content of about 98 per cent. For the rest it contains about 1 per cent. of iron in addition to slight quantities of slag. Absolutely pure, slag-free beryllium has a Be content of about 99.5 per cent. and has an average iron content of about 0.3 to 0.4 per cent. and traces of Al and C too minute for the actual quantities to be ascertained. Such pure beryllium is, however, considerably more expensive and can only be had in small quantities.

Beryllium can also be had as an alloy with 20 per cent. of copper or nickel. Such beryllium containing heavy metals is highly adapted for producing beryllium alloys which are important in a technical sense considering that the losses of beryllium due to further alloying amount to only 1 to 3 per cent. If alloys are made with beryllium not containing heavy metals, the losses increase to 5 and 10 per cent. and even more. In view of its great affinity to oxygen and the extraordinarily high power of deoxidising due to this peculiarity, beryllium has a very wide field of application as a deoxidising agent. For all purposes in which experiments have been carried out, the power of its action renders it distinctly superior to all known deoxidising agents such as P, Al, Mg, Li, etc.

The deoxidising action of beryllium has been established for copper castings. Whereas, for instance, 0.02 per cent. of phosphorus, the usual deoxidising agent, gives the copper casting a conductivity of about 44, the conductivity induced by 0.01 per cent. Be amounts to 53. If 0.02 to 0.03 per cent. Be is added, it is even possible to get a conductivity of 56. Compared with Al, Mg and Li, which are also used for deoxidation, beryllium offers the advantage that it does not call forth any of the undesired surface flaws accompanying the casting of copper, quite the contrary, the metal cast is absolutely homogeneous, without pores, and quite dense. Another advantage of beryllium on phosphorus consists in its being able to remove sulphur from castings.

As the quantity required for deoxidation is extraordinarily small, the price of beryllium is of no importance in this field of application, especially as the increased conductivity and the reduction in section of armatures cast from copper which, amounting to 10 to 20 per cent., not only counterbalances the higher cost, but actually results in saving money. For this reason deoxidising with beryllium is very often practised in industrial plants.

The chief advantage of beryllium, however, consists in the fact that small quantities, added to heavy metals, supply alloys of exceptionally good quality. Alloys of beryllium and copper are worthy of special note in this respect; add 2.5 per cent. of beryllium to copper, the hardness of the latter is increased sixfold and its tensile strength fivefold. As in the case of steel, such alloys can be subjected to different heat-treatment processes till they become as hard or tough as spring steel, in which case they have attained the state of the maximum quality desired.

Special notice must be taken of the fact that beryllium-copper casting may be hardened. As to the hardness, it increases in a similar way to that of rolled alloy. The tensile strength amounts to about 55 tons per sq. in.

As regards its strength, 2.5 per cent. of beryllium bronze alloy is equal to the best spring steel. The tensile strength amounts to about 85 tons per sq. in. An alloy with 3 per cent. of beryllium after heat treatment has a tensile strength of 95 tons per sq. in. Aluminium bronze rolled till it is as hard as spring steel has a tensile strength of only 57 tons per sq. in., standard rolled bronzes on the average have 38 to 44 tons per sq. in., tin-bronze only 27 tons per sq. in.

The transverse strength amounts to about 136 tons per sq. in. This high degree of strength enables the designer using beryllium bronze appreciably to lower the weight of structural parts by reducing their sections.

The elasticity of beryllium bronze is extraordinarily high, so that the metal is at present being used in large quantities for springs subjected to great mechanical stress. The metal is suited for this purpose by its extraordinarily low tendency to fatiguing. The fatiguing phenomena of structural parts and of all kinds of springs made of beryllium manifest themselves much later than in the case of other bronzes or steels. There are quite a number of experimental results at hand to prove this assertion. The experiments in this field, however, are not yet complete, so that further advantageous developments are to be expected. It was found, for instance, that a helical spring of beryllium bronze could stand three million vibrations without its tension being in the least affected. Steel springs of the best quality could not withstand more than two million vibrations of the same strength. Up to now leaf springs can withstand ten million alternations without breaking, whilst recently a spring has even been alternated fifteen million times and is still intact. Leaf springs of phosphor-bronze generally fracture after having been bent 400,000 times, the maximum efficiency being one million alternations. Springs of beryllium bronze can be subjected to a stress four and a-half times that of brass, three times that of German silver, two and a-half times that of phosphor-bronze or nickeline.

A further advantage consists in the fact that beryllium bronze is less subject to corrosion than steel, especially spring steel. The shearing resistance of a bronze containing 2½ per cent. of beryllium amounts to about 48 tons per sq. in.

No bronze has a higher electrical conductivity than a beryllium bronze with a Be content of 2.5 per cent., which perhaps even surpasses all alloys in this respect. According to the thermal treatment, the electric conductivity amounts from 17 to 19, whereas the conductivity of aluminium bronze or phosphor-bronze respectively amounts to about 7 to 10. The greater conductivity of beryllium bronze therefore permits of correspondingly reducing the sections of live parts, reductions of this kind sometimes amounting to 50 per cent. It follows that the weight of the apparatus can be greatly reduced in this way. With beryllium bronze the conditions governing the conductivity of heat are somewhat similar.

Recent experiments have shown that beryllium bronzes with a Be content of only 1 to 2 per cent. are highly suited for use as metals for bearings. Journal boxes of this metal, on being subject to uninterrupted tests, have suffered only a sixth of the wear and tear of tin bronze without the shaft being affected. At present a number of endurance tests are being carried out in this field, but no final results have yet been obtained. So far, however, reason for the greatest satisfaction is indicated.

Beryllium bronze is very easy to cast. No difficulties such as attend the casting of aluminium bronze manifest themselves. Above all things, the castings are devoid of surface flaws and pores. In its soft state, before having been hardened, it can be machined in any desired way. For instance, it is definitely easier to roll than most other bronzes. It can be made in the form of castings, wire, sheets, and tubes. It can be forged, stamped, and jumped. At a temperature of 600 to 700 deg. C. the bronze can be swaged in the same way as brass. When hardened, the hardness of beryllium bronze amounts to about 400 Be. The use of beryllium bronze entails considerable saving, increases safety in working, and renders many costly repairs unnecessary. The high price to be paid for beryllium bronze at present is justified by the advantages mentioned. The alloy is being used in ever increasing quantities by the interested industries.

In the case of springs and small parts especially, the price of which compared with that of the whole machine is not worth mentioning, but which are of utmost importance for the reliable working of the machine, the higher cost occasioned by the use of beryllium bronze is more than counter-balanced by the fact that accidents, serious breakdowns, and other mishaps are avoided.

Percussion caps and brush holder springs for electric motors, springs for automatic telephones, sliprings for high-speed motors, carriage springs for aeroplanes, valve springs, etc. Beryllium is also used for surgical instruments, and for similar purposes. It is also necessary to draw attention to bronzes containing 1 to 2 per cent. of beryllium, which are used for nozzles, bearing journals, etc.

The alloys of nickel or cobalt and beryllium have much the same properties as the beryllium copper alloys. The resistance these alloys offer to the action of salt water and their high degree of toughness up to 400 deg. C. are remarkable. The research in this field as well as in the beryllium iron field have not yet come to an end. Up to now reason is given, however, to expect a great number of further uses to which beryllium can be put; for instance, iron-alloys, already remarkable improvements.

It is reported from Vienna that a new plant for manufacturing beryllium metal is being erected at Graz, and will be producing next month. It is to be known as the Dr. Kurt Steidler Beryllium Company. It is thought that beryllium can be made at the price of £13 10s. to £16 per lb.

Electric Welding of Steel Structures.—In reviewing the progress made in electric-arc welding of steel structures, Mr. E. P. S. Gardner, in addressing the Junior Institution of Engineers, recently stated that although the process had already been applied in many directions, the field of application was so great that little more than the fringe has yet been touched. In strengthening bridges often rendered necessary by increased traffic loads or corrosion, the main advantages of electric welding were generally: (1) A lower cost than alternative methods of reinforcement; (2) avoidance of delay to traffic using the bridge; (3) in most cases underpinning or staging unnecessary, and (4) the existing structure was not weakened or disturbed in the initial stages by the replacement of members and rivets. The plants employed to generate current for the work were usually self-contained petrol-driven units mounted on a truck. The negative terminal of the dynamo was connected to the structure and the positive to the electrode holders through small regulators for varying the current as required, these being generally situated beside the operators. Examples of bridge strengthening in this country as well as in Australia and the United States were shown by slides. With regard to certain bridges on the London and North Eastern Railway, it was stated the cost of strengthening by electric welding was one-fifth the estimated cost of renewal, and there was no delay to traffic. The application of electric welding to the complete fabrication and erection of large steel structures opened a wide field; the most notable application to ship construction was the all-welded motor vessel "Fullagar," built in 1920 by Messrs. Cammell Laird & Company having a gross tonnage of 398 tons and a length of 150 ft. Large pipe lines in many parts of the world had been constructed by the process, and examples of one in the British Isles was illustrated. One of the first completely welded bridges of any magnitude was constructed at Toronga, Australia, 100 ft. in length, with a clear central span of 50 ft.

XUM

STANTON
PIG
IRON
THE STANTON
IRONWORKS
COMPANY LIMITED
NEAR
NOTTINGHAM

Trade Talk.

A contract for four suction dredgers have been placed with Messrs. Lobnitz & Company, Limited, Renfrew, by the Mexican Government.

As a step towards rationalisation, two important ironworks at Dillenburg, Rhineland, are being closed down. This action involves the discharge of over 1,200 men.

A deputation of the Federation of British Industries visited the Treasury on Thursday last week and interviewed the Chancellor of the Exchequer on the question of taxation and industry.

The London office of Messrs. George Ellison, Limited, engineers and makers of electric control switchgear, has been removed from 25, Victoria Street to 131, Victoria Street, London, S.W.1.

The annual supper and dance of the Royal Metal Trades Pension and Benevolent Society was held at the Hotel Cecil, London, recently. There was a large attendance, over which Mr. T. S. G. Ramsay presided.

Mr. Frank O. Ellison, of Willington, Derby, is now representing Messrs. Goodall, Clayton & Company, Limited, engineers and contractors, Hunslet, Leeds, in Nottinghamshire, Derbyshire, the Midlands and Lancashire.

The Progressive Engineering Company (1929), Limited, announce that their office at Aylestone Park, Leicester, has been closed. Correspondence should be addressed to their London office at 235, Upper Thames Street, London, E.C.4.

The Refractories Department of Messrs. General Refractories, Limited, Sheffield, has secured in face of severe foreign competition an order for the refractory linings for the zinc reduction furnaces to be erected at Tunis in North Africa.

Messrs. Hudswell, Clarke & Company, Limited, Hunslet, Leeds, have recently completed a Diesel locomotive destined for main-line work on the Jurin railway in Chile. The engine was supplied by Messrs. J. & H. McLaren, Limited, Hunslet.

The L.M.S. Railway Company have placed a contract with Messrs. William Denny & Brothers, Limited, Dumbarton, for a cargo steamer for their Holyhead-Dublin (Northwall) service. The vessel will be 310 ft. in length and have a speed of 15½ knots.

Considerable damage was caused by an outbreak of fire in the patternshop of the North British Locomotive Company, Limited, Springburn, Glasgow. The premises, a two-storey building containing a large number of wooden patterns, were totally destroyed. Business, however, will not be interfered with.

Messrs. Vickers-Armstrongs, Limited, launched from their Barrow-in-Furness yard on Tuesday, March 4, the steamer "Lady of Mann," built for the Isle of Man Steam Packet Company. The Duchess of Atholl performed the launching ceremony.

The Bon-Accord Engineering Company, Limited, Aberdeen, of which Mr. D. A. Coutts, A.M.I.Mech.E., is the managing director, have been appointed contractors to the Egyptian Government. The firm recently supplied a large cleaning and dressing plant for the Egyptian Government.

The first mortgage debenture holders have appointed Mr. L. B. Davison as receiver of Messrs. John Kenyon & Company (Sheffield), Limited, steel and saw manufacturers. The receiver states in a circular letter that the debenture holders are taking steps for the payment of all unsecured creditors in full.

Further works developments are foreshadowed at Billingham-on-Tees. Imperial Chemical Industries, Limited, are negotiating with the Tees Conservancy Commissioners for the purchase of an area of foreshore. It is understood that part of the land is required for the construction of a dock to deal with the firm's export trade.

The Construction Department of General Refractories, Limited, Sheffield, announces that Messrs. The Shilton Brick & Tile Company, Limited, has placed with it an order for three Williams tunnel brick-dryers, intended to supersede partially the system of drying bricks singly on concrete floors heated by exhaust steam.

Messrs. William Beardmore & Company, Limited, Dalmuir, have received orders for two cargo steamers, of 9,000 tons deadweight, for Messrs. John Campbell & Son, Glasgow. Reciprocating engines, working in conjunction with Bauer-Wach low-pressure turbines, will be provided by the builders, and will be constructed under the supervision of Messrs. John Crookston & Son, Limited.

The single-screw tank motorship "Evina," built for Mr. H. E. Hansen Tangen, of Christiansand, by Messrs. Sir W. G. Armstrong, Whitworth & Company (Shipbuilders), Limited, was launched from the builders' South Yard on February 28. The vessel is designed to carry 8,840 tons on a mean draft of 25 ft. 10 in. The propelling machinery consists of an Armstrong-Sulzer two-stroke single-acting six-cylinder Diesel engine.

Mining & Industrial Equipment, Limited, 11, Southampton Row, London, W.C.1, report the receipt of new orders from English firms for a Raymond pulveriser. Raymond separating plant, two tubular dust collectors, a five-roller Raymond mill, and three screens; from Germany for two screens; from Australia for three Impax mills and one Raymond-Lupulco mill; from Portugal for a 3-ft. by 8-in. ball mill; and from France for three Raymond and twelve Hardinge mills, one rod mill and one Raymond pulveriser.

Plans for the merger of the Bethlehem Steel Corporation with Youngstown Sheet & Tube Company have reached a stage where they can be submitted to shareholders of the latter company for their approval. The Bethlehem Steel Corporation is second as a producer only to the United States Steel Corporation, and recently it absorbed three other companies in Washington and California after the United States Steel Corporation had acquired the Columbia Steel Corporation on the Pacific Coast. Excluding the California and Washington companies, the assets of the Bethlehem and Youngstown concerns together amount to over $1,000,000,000 (about £200,000,000), the Bethlehem Steel Corporation having three-quarters of the total assets.

A meeting of the employees of the Motherwell Iron & Steel Works was held recently to consider the offer by the management of a new base rate of wages. A few weeks ago certain sections of the workers were changed over from the iron rates to the steel rates, which involved a reduction of approximately 14 per cent. The workers affected entered a protest, but continued at work whilst negotiations were being carried out by the Iron and Steel Trades Confederation with the employers in an endeavour to obtain a satisfactory settlement. The effort seems to be progressing towards a successful conclusion. The base rate offered appeared to the men good in some respects, but in other directions further information seemed desirable, and consequently further discussions are to be held with the employers.

We learn from a correspondent that Thos. W. Ward, Limited, Sheffield, have acquired the undertaking of the Denby Iron & Coal Company, Limited, near Derby. The Denby Iron & Coal Company, Limited, was registered in 1890, with a capital of £30,000, afterwards increased to £100,000. The plant includes four blast furnaces, colliery and brickworks. The blast furnaces each had a capacity of 350 tons per week. The intentions of the purchasers are not yet known, but hope is expressed in the neighbourhood that the plant will not be totally dismantled, as several hundred men were employed by the Denby Company. In the past Messrs. Wards have always been sympathetic to workmen in similar circumstances, and have generally refrained from dismantling until there was no possible hope of restarting works they had purchased.

New Companies.

Aluminium Alloys, Limited.—Capital £100. Directors: A. D. Thomson, 75, Coldershaw Road, Ealing, W.; and Dorothy Wilson.

Universal Steel Tube Company, Limited, Queens College, Paradise Street, Birmingham.—Capital £5,000. Directors: E. W. P. Lines and R. S. King.

Suckling & Thomas, Limited.—Capital £3,000. Metal merchants and manufacturers, etc. Directors: P. J. Thomas, 2, York Avenue, Wolverhampton; and S. C. Suckling.

British Boiler Company & General Foundries (1930), Limited, 111, Charing Cross Road, London, W.C.—Capital £3,000. Directors: J. Elliott, H. A. Watson, H. J. Cann and C. W. Coleman. Secretary: F. J. Rose.

Joseph Cook, Sons & Company (1930), Limited, Usworth Hall, New Washington, Co. Durham.—Capital £30,000. Iron and steel manufacturers and founders, etc. Directors: R. T. Cooke, D. Kellett, M. H. Kellett and A. Kirkup, jun.

Personal.

Dr. G. C. Clayton was elected President of the Institute of Chemistry at the annual general meeting on Tuesday, March 4.

Mr. S. R. Beale, of Messrs. L. Sterne & Company, Limited, Crown Ironworks, Glasgow, has been elected an ordinary director of the Union Bank of Scotland.

Mr. T. H. Miller, of Wolsingham, is taking up an appointment as representative on the North-East Coast of Messrs. Edgar Allen & Company, Limited, Sheffield.

Mr. H. D. Boyd has been appointed sales manager to Messrs. Edgar Allen & Company, Limited, as from March 1. For 11 years he has been the representative for the North-Eastern Counties, and this position will now be filled by Mr. T. H. Miller.

Wills.

Walker, H., a director and for 20 years chairman of Messrs. Clarke, Chapman & Company, Limited, iron-founders, of Gateshead £78,631

Lister, Sir Robert Aston, C.B.E., founder of R. A. Lister & Company, Limited, agricultural implement manufacturers, of Dursley, Glos. £294,982

Obituary.

Sir Alexander Gracie, the Scottish engineer and shipbuilder, died suddenly in London on March 2. Sir Alexander Gracie was associated for many years with the Fairfield Shipbuilding & Engineering Company, Limited, of which he was chairman and managing director from 1909 to 1919, when he retired from the chairmanship, although retaining his position of managing director until June, 1920. At the time of his death he was a director of Messrs. Cammell, Laird & Company, Limited, the English Electric Company, Limited, and the Metropolitan Cammell Carriage, Wagon & Finance Company, Limited. He was in his 70th year.

Contracts Open.

Bristol, March 17.—Iron castings, wrought iron and steel, black bolts and nuts, iron piping and lead, for the Port of Bristol Authority. Mr. W. P. Wordsworth, Avonmouth Dock.

Buenos Aires, May 22.—Three centrifugal pumping sets, etc., for the Department of Sanitary Works. The Department of Overseas Trade. (Reference A.X. 9,212.)

Burnley, March 15.—Cast-iron goods, for the Gas Committee. The Gas Engineer, Gas Offices, Parker Lane, Burnley.

Holt, Norfolk, March 18.—200 yds. of cast-iron water main, etc., for the Erpingham Rural District Council. Mr. A. Burrell, Station Road, Holt, Norfolk.

Manchester, March 17.—Iron and steel and tool steel, for the Corporation. Mr. H. C. Lamb, chief engineer and manager, Electricity Department, Town Hall, Manchester.

South Africa, June 14.—Ore-crushing plant, for the South African Iron & Steel Industrial Corporation, Limited. The Office of the High Commissioner for the Union of South Africa, South Africa House, Trafalgar Square, London, W.C.2. (Fee £25, returnable.)

Sydney, N.S.W., April 28.—Pumping plant, for the Department of Public Works, New South Wales. The Department of Overseas Trade. (Reference A.X. 9,219.)

Reports and Dividends.

Hadfields, Limited.—Dividend of 2½ per cent. for the year.

North British Locomotive Company, Limited.—Dividend of 2½ per cent., less tax, on the ordinary shares.

Scottish Tube Company, Limited.—Dividend on the ordinary shares for the past year of 2½ per cent., less tax.

British Metal Corporation, Limited.—Net profit, £195,039; brought in, £25,184; preference dividend, £54,000; dividend of 10 per cent. on the ordinary shares, £90,000; to reserve, £50,000; carried forward, £26,223.

Telephones:
SHEFFIELD
22311 (3 lines)
LONDON
1483 Central
GLASGOW
South 1580
WORKSOP 205
AMBERGATE 7
STOCKSBRIDGE 27
GALSTON 49

"SERVICE BCM/GX FIRST."

MANUFACTURERS & PRODUCERS OF REFRACTORY MATERIALS OF EVERY DESCRIPTION.
BRICKMAKERS · QUARRY AND MINEOWNERS CONTRACTORS & EXPORTERS.

GENERAL REFRACTORIES
LIMITED
Incorporating
THE GENERAL REFRACTORIES CO. LTD. THE MIDLAND REFRACTORIES CO., LTD.
THOMAS BROOKE & SONS LTD. WORKSOP BRICK CO. LTD. GUISELEY SILICA CO. LTD.

Telegrams
"GENEFRAX"
Sheffield
London
Glasgow
Worksop
Monomarks
BCM / GX
BCM/ Magnesia
BCM/ Coroma
BCM/ Pyrolyte
BCM/ Insulite

KELHAM ISLAND MILLS SHEFFIELD · LOWGROUNDS BRICKWORKS WORKSOP · Notts. · BULLBRIDGE BRICKWORKS AMBERGATE · Derbys · GAYTON ROAD MILLS KINGS LYNN · THE BATTS MILLS WOLSINGHAM · Dur. · BRACKENHOOR FIRECLAY WORKS · STOCKSBRIDGE · LOUDOUN MILLS GALSTON · Ayrshire
AND AT MANSFIELD, WARSOP, EBBERSTON, CORBRIDGE, BRAMCOTE, LUFFENHAM, TOW LAW, MONTGREENAN &c.&c.

LONDON OFFICE
20 Budge Row E.C.4. (M^r A.C. Turner)

Head Office
Wicker Arches, SHEFFIELD

GLASGOW OFFICE
82 Dale St. C.5 (M^r A.W. Montgomery)

IF THE GIN IS HALF WATER, ANYBODY CAN AFFORD TO SELL IT AT A LOW PRICE,

BUT

IF YOU HAVE TO USE HALF AS MUCH AGAIN TO GET THE SAME EFFECT—

IT'S NOT CHEAPER

IT'S REALLY DEARER—ISN'T IT?

THIS IS JUST AS TRUE OF STEEL MOULDING SAND

There is no Steel Foundry Sand on the market so highly concentrated as

"EXTRA STRONG YORKSHIRE SAND"

and none that goes as far and gives such a strong reliable bond to Silica Sand or Floor Sand.

SAMPLES FREE ON APPLICATION.

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—The lassitude which, for some time past, has depressed the pig-iron industry in the Cleveland area still persists, with the result that stocks in hand are accumulating to a certain extent, furnace output at the moment being more than adequate to meet the limited demand for foundry pig now experienced in the Tees-side market. Not only is the demand on account of the home foundries on a greatly diminished scale, but sales to Scottish consumers are now merely nominal in tonnage, while shipments abroad have declined slightly, the figures showing 16,168 tons for February, as against 16,656 in the preceding month. It is not, therefore, surprising that an atmosphere of pessimism pervades the Cleveland iron markets, and although it is urged by consumers that the time is opportune for a drastic revision of prices to lower levels, furnace interests are disinclined to accept that view of the position in the face of the uncertainty of the fiscal and legislative outlook. Spring requirements for the most part have yet to be covered, but since supplies are ample all the consuming works are able to meet their current needs without difficulty and may not improbably continue on these lines until the presentation of the Budget clarifies the situation. Meantime, prices are still maintained, current fixed minimum prices being:—No. 3 G.M.B. pig-iron, 72s. 6d.; No. 1 Cleveland foundry iron, 75s.; No. 4 foundry, 71s. 6d.; No. 4 forge, 71s. per ton.

The demand for hematite in the North-East Coast market continues to decline, while makers hold very heavy stocks, which are increasing every week. This is not only a financial burden, but also a source of market weakness, since it intensifies the competition for the few orders in the market. Thus, prices are drooping. Mixed numbers are now quoted at 77s., with No. 1 quality at 77s. 6d. On the North-West Coast, Bessemer mixed numbers are still quoted at 79s. per ton, at works.

LANCASHIRE.—The general impression prevailing amongst consumers of foundry pig in this area is that as current prices are likely to stand for some time to come, nothing is to be gained by forward buying, and sales, consequently, are restricted to immediate requirements, although a fair aggregate tonnage of iron is being taken by local foundries. Current quotations, meanwhile, continue firm, with Staffordshire and Derbyshire on the old basis of 77s. and Scottish brands at around 95s., all per ton, delivered locally.

THE MIDLANDS.—Foundries in the Black Country area are at the moment only moderately employed, and, pending a revival of demand, are confining purchasing of pig-iron to minimum proportions. For the limited volume of business passing quotations rule as follow:—Northants No. 3, 75s.; Derbyshire No. 3 and North Staffordshire No. 3, 78s. 6d., delivered local stations.

SCOTLAND.—There is no change to report in the condition of the Scotch pig-iron market, and business continues to be very restricted. The official minimum price of 78s. for No. 3 Scotch foundry iron at the furnaces is still in force. Although the prices of other irons are weakening, the Scotch makers give no indication of any change in their prices.

Finished Iron.

There is little of a satisfactory nature to report concerning the bar-iron market. Apart from the continued fairly satisfactory state of the demand for Staffordshire marked bars, there is little business developing for cheaper grades. The few mills which are operating are quite unable to gather sufficient orders for crown bars to keep mills in regular operation. Quotations from this and other districts for crown quality are from £10 to £10 10s., and nut and bolt iron is at £9 2s. 6d. to £9 7s. 6d. The price of marked bars is £12 10s. at works.

Steel.

The situation as concerns the British steel industry affords little sign of improvement, and although a certain amount of inquiry has been received of late only a comparatively small portion of it has materialised into business. At Sheffield, there is rather heavy competition from the Continent in basic billets and wire rods, and the depression in Siemens acid billets makes it difficult to maintain the Association price of £9 10s. Some open-hearth furnaces are ceasing to operate, and generally the position is rather unsettling. Current prices are as under:—Siemens acid billets, £9 10s.; basic billets, soft, £6 10s.; medium hard, £7 2s. 6d.; medium, £8 2s. 6d.; hard, £9 2s. 6d. to £9 12s. 6d.; basic wire rods, soft, £8; medium hard, £9 15s. to £10; hard, £10 10s. to £11; acid, £12 5s. to £12 10s. In the tinplate market, business is quiet and prices a shade easier, current quotations ruling for coke qualities at 18s. 3d. to 18s. 6d., net cash, f.o.b. Welsh ports.

Scrap.

Business conditions in the markets for this class of raw material may be best described as almost stagnant as far as buying is concerned, and on Tees-side this week only small parcels of heavy cast iron, ordinary quality, were sold at 62s. 6d., while there was very little demand for machinery quality, which is still quoted at 65s. per ton. In the Midlands, very little alteration is reported in the market for cast-iron scrap. For heavy machinery quality 70s. delivered is still offered, and 65s. for ordinary heavy metal. Light cast iron is weak at 59s. to 60s. delivered. In Scotland, the position is about the same as when last reported, with only a moderate demand for machinery cast iron at 68s. 6d. to 70s., heavy ordinary 65s. and light cast iron at 60s., all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—In the markets for base metals of late, a distinctly weaker tendency in values has developed in all sections, as marked in the case of warrant copper, which is now some £14 below the level current at this date last year, while the discrepancy in prices is still further emphasised in the quotation for electrolytic, which is causing considerable concern to European manufacturers, who have great difficulty in carrying on operations under the entirely artificial market conditions enforced by the Copper Exporters, Incorporated.

Closing quotations are :—

Cash.—Thursday, £68 to £68 5s.; Friday, £67 7s. 6d. to £67 10s.; Monday, £67 18s. 9d. to £68; Tuesday, £69 15s. to £69 17s. 6d.; Wednesday, £69 15s. to £70.

Three Months. — Thursday, £67 15s. to £67 17s. 6d.; Friday, £66 12s. 6d. to £66 15s.; Monday, £66 12s. 6d. to £66 15s.; Tuesday, £67 10s. to £67 12s. 6d.; Wednesday, £68 5s. to £68 10s.

Tin.—The issue of the official statistics for February had an immediate adverse effect upon last week's markets, leading to a serious decline in values amounting to as much as £10 per ton, at one time falling to the lowest level since 1922. The increase in the total visible supply was as much as 4,147 tons, a figure which was considerably higher than was anticipated. This is attributed mainly to the low official deliveries in the United States and the heavy shipments from the East.

Official closing prices :—

Cash.—Thursday, £161 10s. to £161 15s.; Friday, £159 5s. to £159 10s.; Monday, £161 10s. to £161 15s.; Tuesday, £163 15s. to £164; Wednesday, £166 5s. to £166 7s. 6d.

Three Months. — Thursday, £163 15s. to £164; Friday, £161 10s. to £161 15s.; Monday, £163 15s. to £164; Tuesday, £165 15s. to £166; Wednesday, £168 5s. to £168 10s.

Spelter.—The depression in the spelter market continues unabated. At each successive fall of the price it was considered that quotations had reached their lowest limit, but, with mild fluctuations, prices continued steadily downward. A drastic curtailment of output seems inevitable, as smelters are faced with a heavy loss on their operations.

Daily quotations are :—

Ordinary.—Thursday, £18 1s. 3d.; Friday, £17 15s.; Monday, £18 1s. 3d.; Tuesday, £17 18s. 9d.; Wednesday, £18 3s. 9d.

Lead.—The lead market is also having a liberal share of the depression which envelopes the non-ferrous metal markets, and a recovery of the Continental demand for pig-lead is needed to reduce some of the large stocks in this country.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £19 2s. 6d.; Friday, £18 12s. 6d.; Monday, £18 15s.; Tuesday, £18 15s.; Wednesday, £19 8s. 9d.

Students' Corner.

Q.—Does any relation exist between thickness of the chill and thickness of casting to be chilled?

A.—With chilled rolls the character and depth of chill depend on the nature of the iron used, the thickness of metal where the chill is applied, and the pouring temperature of the metal. As the diameter of a solid roll to be chilled increases the greater must be the thickness of the chill, not to resist the pressure of metal, but to provide a means that will extract the heat rapidly from the molten iron and so chill the surface of the casting. The thickness of chills for different-sized rolls may be as a guide governed by the following :—

Dia. of roll.	Thickness of chills.
4 in.	2 in.
5 in.	2½ in.
6 in.	3¼ in.
8 in.	3½ in.
9 in.	3⅝ in.

For rolls exceeding 9 in. dia. an increase of ⅛ in. should be allowed for every increase of 1 in. in the diameter of the roll. Thus a 10-in. roll requires a chill 3¾ in. thick, and so onwards.

Q.—In what way do castings poured into permanent metal moulds produce stronger, denser and sounder castings compared to similar castings poured into sand moulds?

A.—When a permanent metal mould is filled with fluid iron, it almost instantly freezes. It is stated that cast iron on the point of solidification swells, also that during cooling, expansions occur, *id est*, from the liquid to the solid state (solid contraction is not now considered). In the first place then, a denser iron may be the result of pouring into a metal mould which is rigid and will not yield to a swell on solidifying, or to any expansions during solidification. Thus the casting would have the benefit of compression on the very short period the casting may be plastic. Secondly, when a metal is in a highly fluid state we say that its constituents are, more or less, dissolved in each other, and that during cooling the constituents separate out into segregated areas. If the fluid metal is rapidly solidified such segregations are prevented, also the rapidity with which the metal cools also prevent the growth of large crystals.

Comparing the same casting made in sand, the walls of the iron permanent mould is a good conductor of head, whilst the walls of sand is a poor conductor of head. Also in the case of a sand mould its walls would yield to any possible swelling of the metal during freezing, and would give quite easy to possible expansions, thus the casting in sand has not the compressive force around it, neither will it prevent segregation, or the growth of large crystals due to slow cooling.

BLACKING,
PLUMBAGO,
CORE GUM,
WHITE DUST,
COAL DUST.

ESTABLISHED 1863.

JAS. DURRANS & SONS, LTD.
PHŒNIX WORKS, PENISTONE, near SHEFFIELD.

Telephone:
21 PENISTONE.
Telegrams:
"DURRANS, PENISTONE."

FOUNDRY EQUIPMENTS

LADLES,
FIRE BRICKS,
STONE FLUX,
CASTING CLEANERS,
PIPE NAILS,
SPRIGS,
WIRE BRUSHES,
BELLOWS,
CUPOLAS,
GANISTER,
LOAM AND SAND MILLS,
STUDS,
CHAPLETS,
BRUSHES,
CORE ROPES,
BUCKETS,
SPADES, Etc.

Write for Illustrated Catalogue on Blacking and Foundry Requisites.

CAST IRON FLANGED PIPES
2 in.–12 in. & CONNECTIONS. to 24 in. dia.
WE HAVE FIFTY YEARS OF ACCUMULATED EXPERIENCE AND METAL PATTERNS.
JAMES & RONALD RITCHIE, LTD.,
Telephone: 52 & 53. MIDDLESBROUGH. Telegrams: "Ritchie, Middlesbrough."

R. B. TENNENT, LTD., COATBRIDGE, N.B.
Telegrams: "Tennent, Founders, Coatbridge." Established 1857. Telephone: No. 425-426, Coatbridge.
IRON & STEEL FOUNDERS
SPECIAL AIR FURNACE IRON. SIEMENS' STEEL ONLY.
HEAVY CASTINGS
OF ALL KINDS FOR IRON AND STEEL WORKS
Iron Castings up to 100 tons each. Steel Castings up to 40 tons each.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	69	15	0
Three months	68	5	0
Electrolytic	83	10	0
Tough	75	15	0
Best selected	76	5	0
Sheets	110	0	0
India	90	0	0
Wire bars	84	5	0
Do. March	84	5	0
Do. April	84	5	0
Ingot bars	84	5	0
H.C. wire rods	86	5	0
Off. av. cash, February	71	10	3¾
Do., 3 mths., February	68	18	6⅜
Do., Sttlmnt., February	71	10	3
Do., Electro, February	83	17	6
Do., B.S., February	78	5	7½
Do., wire bars, February	84	5	0
Aver. spot price, copper, Feb.	71	10	3¾
Solid drawn tubes			15d.
Brazed tubes			15d.
Wire			11½d.

BRASS.

Solid drawn tubes	12¾d.
Brazed tubes	14¼d.
Rods, drawn	12½d.
Rods, extd. or rlld.	7¼d.
Sheets to 10 w.g.	10⅞d.
Wire	10⅞d.
Rolled metal	10⅜d.
Yellow metal rods	7⅛d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8⅛d.

TIN.

	£	s.	d.
Standard cash	166	5	0
Three months	168	5	0
English	167	5	0
Bars	167	0	0
Straits	168	10	0
Australian	167	10	0
Eastern	166	0	0
Banca	170	5	0
Off. av. cash, February	173	16	6
Do., 3 mths, February	176	14	9
Do., Sttlmt., February	173	15	7½
Aver. spot, February	173	16	6

SPELTER.

	£	s.	d.
Ordinary	18	3	9
Remelted	16	10	0
Hard	15	0	0
Electro 99.9	20	5	0
English	18	5	0
India	16	0	0
Zinc dust (Nom.)	26	0	0
Zinc ashes	5	0	0
Off. aver., February	19	9	10½
Aver., spot, February	19	4	2½

LEAD.

	£	s.	d.
Soft foreign ppt.	18	15	0
English	20	0	0
Off. average, February	21	2	10⅛
Average spot, February	21	3	9

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	28	0	0
Do. V.M. ex-whf.	26	0	0
Rods	30	0	0
Boiler plates	24	10	0
Battery plates	25	0	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	40	10	0
Chinese	29	10	0
Crude	17	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	22	17	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£7 17 6
45/50%	£11 10 0
75%	£19 0 0
Ferro-vanadium—	
35/50%	12/9 lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/2 lb. Mo.
Ferro-titanium—	
23/25% carbonless	9d. lb.
Ferro-phosphorus, 20/25%	£16 0 0
Ferro-tungsten—	
80/85%, c. fr.	3/1½ lb.
Tungsten metal powder—	
98/99%	3/4½ lb.
Ferro-chrome—	
2/4% car.	£30 7 6
4/6% car.	£23 7 6
6/8% car.	£22 12 6
8/10% car.	£22 2 0
Ferro-chrome—	
Max. 2% car.	£33 15 0
Max. 1% car.	£38 0 0
Max. 0.70% car.	£40 10 0
70% carbonless	11d. lb.
Nickel—99% cubes, or pellets	£175 0 0
Ferro-cobalt	9/6 lb.
Aluminium 98/99%	£95 0 0
Metallic chromium—	
96/98%	2/7 lb.
Ferro-manganese (net)—	
76/80% loose	£12 10 0
76/80% packed	£13 10 0
76/80%, export	£12 15 0
Metallic manganese—	
94/96%, carbonless	1/4 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 2
Finished bars, 18% tungsten	£0 3 0

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{3}{16}$ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ¼ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.		£	s.	d.
South Wales—							
Heavy steel					3	6	0
Bundled steel and shrngs.	3	0	0	to	3	4	0
Mixed iron and steel	3	0	0	to	3	1	6
Heavy cast iron	2	18	0	to	2	19	0
Good machinery for foundries	3	0	0	to	3	2	6
Cleveland—							
Heavy steel					3	2	0
Steel turnings					2	13	0
Cast-iron borings					2	10	0
Heavy forge					3	16	0
W.I. piling scrap					3	11	6
Cast-iron scrap	3	2	6	to	3	5	0
Midlands—							
Ord. cast-iron scrap					3	5	0
Heavy wrought					4	0	0
Steel turnings					2	0	0
Scotland—							
Heavy steel					3	5	0
Cast-iron borings					2	10	0
Wrought-iron piling					3	18	6
Heavy machinery					3	9	0

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	58	0	0
Brass	42	0	0
Lead (less usual draft)	17	10	0
Tea lead	13	10	0
Zinc	11	0	0
New aluminium cuttings	65	0	0
Braziery copper	54	0	0
Gunmetal	54	0	0
Hollow pewter	125	0	0
Shaped black pewter	92	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	75/-
Foundry No. 3	72/6
Foundry No. 4	71/6
Forge No. 4	71/-
Hematite No. 1	77/6
Hematite M/Nos.	77/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	87/-
„ d/d Birm.	95/6
Midlands—	
Staffs. common*	—
„ No. 4 forge*	74/6
„ No. 3 fdry.*	78/6
Shrops. basic	—
„ Cold blast, ord.	—
„ „ roll iron	—
Northants forge*	71/-
„ fdry. No. 3*	75/-
Derbyshire forge*	74/6
„ fdry. No. 3*	78/6
„ basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	80/6
„ No. 3	78/-
Hem. M/Nos.	81/-
Sheffield (d/d district)—	
Derby forge	69/6
„ fdry. No. 3	73/6
Lincs. forge.	71/6
„ fdry No. 3	75/6
E.C. hematite	89/-
W.C. hematite	91/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
„ fdry. No. 3	77/-
Northants foundry No. 3	—
Dalzell, No. 3 (special)	105/- to 107/6
Summerlee, No. 3	95/-
Glengarnock, No. 3	—
Gartsherrie, No. 3	95/-
Monkland, No. 3	95/-
Shotts, No. 3	95/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (or.) nom.					10	15	0
Nut and bolt iron	9	2	6	to	9	7	6
Hoops	10	15	0	to	11	5	0
Marked bars (Staffs) f.o.t.					12	10	0
Gas strip	10	15	0	to	11	5	0
Bolts and nuts, ¾ in. × 4 in.					15	5	0
Steel—							
Ship plates	8	15	0	to	8	17	6
Boiler plts.	9	17	6	to	10	10	0
Chequer plts.					10	12	6
Angles					8	7	6
Tees					9	7	6
Joists					8	10	0
Rounds and squares, 3 in. to 5½ in.					9	7	6
Rounds under 3 in. to ¾ in. (Untested)					8	2	6

and upwards

Flats—8 in. wide and over	8 12 6
„ under 8 in. and over 5 in.	8 17 6
Rails, heavy	8 10 0
Fishplates	12 0 0
Hoops (Staffs)	9 10 0 to 9 15 0
Black sheets, 24 g.	9 15 0
Galv. cor. shts., 24g.	11 17 6
Galv. fencing wire, 8g. plain	12 0 0
Billets, soft	6 2 6 to 6 12 6
Billets, hard	7 10 0 to 8 0 0
Sheet bars	5 17 6 to 6 5 0
Tin bars	5 17 6 to 6 5 0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/3½
Sheet to 10 w.g.	1/4½
Wire	1/6
Rods	1/5
Tubes	1/9½
Castings	1/4

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	10d. to 1/4
Rolled—	
To 9 in. wide	1/4 to 1/10
To 12 in. wide	1/4½ to 1/10½
To 15 in. wide	1/4½ to 1/10½
To 18 in. wide	1/5 to 1/11
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6 to 2/-
Ingots for spoons and forks	10d. to 1/6½
Ingots rolled to spoon size	1/1 to 1/9½
Wire round—	
3/0 to 10 G.	1/7½ to 2/2½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	20 76
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	15.00
Basic	20.26
Bessemer	20.76
Malleable	20.76
Grey forge	19.76
Ferro-mang. 80% d/d	94.00
O.-h. rails, h'y, at mill	43.00
Bessemer billets	33.00
O.-h. billets	35.00
O.-h. sheet bars	33.00
Wire rods	39.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.85
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.85
Skelp, sheared steel	1.85
Steel hoops	2.20
Sheets, black, No. 24	2.65
Sheets, galv., No. 24	3.30
Sheets, blue an'l'd, No. 13	2.25
Wire nails	2.25
Plain wire	2.40
Barbed wire, galv.	2.95
Tinplates, 100-lb. box	$5.25

COKE (at ovens).

Welsh foundry	27/6 to 30/-
„ furnace	22/6 to 25/-
Durham and Northumberland—	
„ foundry	15/6 to 16/6
„ furnace	18/-
Midlands, foundry	—
„ furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box	18/3
„	28×20 „	37/-
„	20×10 „	26/6
„	18¾×14 „	19/3
C.W.	20×14 „	16/-
„	28×20 „	34/3
„	20×10 „	23/6
„	18¾×14 „	17/-
Terneplates	28×20	32/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6	0	0	to	£7	10	0
Bars, hammered, basis	£17	10	0	to	£18	10	0
Bars and nail-rods, rolled, basis	£15	17	6	to	£16	15	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£32	0	0	to	£33	0	0
Faggot steel	£20	0	0	to	£24	0	0
Bars and rods dead soft, steel	£11	0	0	to	£14	0	0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Over ⅛ in. up to 6 in.

	Tubes.	*Fittings.*
Gas	65%	47½%
Water ..	61½%	42½%
Steam ..	57½%	37½%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Mar.	6 ..	68	0	0	inc.	17/6
,,	7 ..	67	7	6	dec.	12/6
,,	10 ..	67	18	9	inc.	11/3
,,	11 ..	69	15	0	,,	36/3
,,	12 ..	69	15	0	No change	

Electrolytic Copper.

		£	s.	d.		
Mar.	6 ..	83	10	0	No change	
,,	7 ..	83	10	0	,, ,,	
,,	10 ..	83	10	0	,, ,,	
,,	11 ..	83	10	0	,, ,,	
,,	12 ..	83	10	0	,, ,,	

Standard Tin (cash).

		£	s.	d.		
Mar.	6 ..	161	10	0	dec.	25/-
,,	7 ..	159	5	0	,,	45/-
,,	10 ..	161	10	0	inc.	45/-
,,	11 ..	163	15	0	,,	45/-
,,	12 ..	166	5	0	,,	50/-

Tin (English ingots).

		£	s.	d.		
Mar.	6 ..	162	15	0	dec.	20/-
,,	7 ..	160	10	0	,,	45/-
,,	10 ..	162	15	0	inc.	45/-
,,	11 ..	165	0	0	,,	45/-
,,	12 ..	167	5	0	,,	45/-

Zinc Sheets (English).

		£	s.	d.		
Mar.	6 ..	28	0	0	No change	
,,	7 ..	28	0	0	,, ,,	
,,	10 ..	28	0	0	,, ,,	
,,	11 ..	28	0	0	,, ,,	
,,	12 ..	28	0	0	,, ,,	

Spelter (ordinary).

		£	s.	d.		
Mar.	6 ..	18	1	3	dec.	6/3
,,	7 ..	17	15	0	,,	6/3
,,	10 ..	18	1	3	inc.	6/3
,,	11 ..	17	18	9	dec.	2/6
,,	12 ..	18	3	9	inc.	5/-

Lead (English).

		£	s.	d.		
Mar.	6 ..	20	10	0	dec.	15/-
,,	7 ..	20	0	0	,,	10/-
,,	10 ..	20	0	0	No change	
,,	11 ..	20	0	0	,, ,,	
,,	12 ..	20	0	0	,, ,,	

AVERAGE MONTHLY PRICES OF RUBIO ORE (MIDDLESBROUGH).

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1890	0 15 4	0 15 4	0 15 4	0 15 4	0 15 4	0 15 4	0 15 4	0 14 3	0 14 3	0 15 7½	0 15 7½	0 15 7½	0 15 2½
1891	0 15 7½	0 14 2½	0 14 2½	0 14 2½	0 13 6½	0 13 6	0 13 3½	0 13 0	0 12 11	0 13 0	0 13 7	0 13 1	0 14 9½
1892	0 13 1	0 12 9	0 12 9	0 12 9	0 12 9	0 11 10½	0 12 1	0 12 1	0 12 2	0 12 0	0 12 0	0 11 11	0 12 4½
1893	0 11 11	0 11 5½	0 11 10	0 11 10	0 12 1½	0 12 3	0 12 1½	0 12 3	0 12 1	0 12 4	0 12 4½	0 12 6	0 12 0½
1894	0 12 6	0 12 6	0 12 7½	0 12 1½	0 12 4	0 12 1	0 12 0	0 12 0½	0 11 10½	0 12 2	0 12 0	0 12 0	0 12 1½
1895	0 12 0	0 12 0	0 11 10	0 12 0	0 12 0	0 12 3	0 12 3	0 12 4	0 12 4	0 12 6	0 12 7	0 12 6	0 12 2½
1896	0 12 6	0 12 6	0 12 9	0 12 9	0 12 9	0 12 7	0 12 9	0 12 9	0 12 9	0 13 6	0 15 0	0 14 9	0 13 1
1897	0 15 3	0 15 6	0 15 3	0 15 0	0 14 0	0 14 3	0 14 3	0 14 0	0 14 0	0 15 0	0 14 3	0 15 3	0 14 8
1898	0 15 0	0 14 4	0 14 9	0 14 6	0 15 0	0 15 0	0 14 0	0 14 0	0 14 9	0 14 9	0 15 0	0 14 9	0 14 7
1899	0 15 0	0 15 3	0 15 6	0 15 6	0 15 9	0 16 0	0 17 6	0 18 0	0 17 9	0 18 0	0 19 0	1 0 0	0 16 11½
1900	1 1 0	1 0 6	1 1 0	1 0 9	1 1 0	1 1 0	1 1 3	1 1 6	1 1 3	1 1 3	1 0 0	0 18 0	1 0 8½
1901	0 17 6	0 16 0	0 15 0	0 14 6	0 15 6	0 15 9	0 14 9	0 15 3	0 15 9	0 15 9	0 15 9	0 15 9	0 15 7½
1902	0 15 6	0 15 0	0 16 0	0 16 0	0 15 6	0 15 3	0 15 6	0 16 0	0 16 0	0 16 0	0 15 9	0 15 6	0 15 8½
1903	0 15 6	0 16 0	0 16 6	0 16 3	0 16 3	0 16 10	0 15 9	0 15 6	0 15 6	0 14 9	0 14 9	0 15 1	0 15 8
1904	0 14 9	0 15 3	0 15 1	0 15 4	0 15 3	0 15 0	0 14 5	0 14 6	0 14 6	0 14 6	0 14 6	0 14 7	0 14 9½
1905	0 15 3	0 15 6	0 15 0	0 15 3	0 15 6	0 15 6	0 15 6	0 15 6	0 16 6	0 18 6	0 18 9	0 18 9	0 16 3½
1906	1 0 0	1 1 6	1 0 0	1 0 0	0 19 6	1 0 0	0 19 6	0 19 4	1 0 6	1 1 6	1 1 9	1 3 6	1 0 7
1907	1 1 3	1 2 6	1 2 6	1 2 0	1 1 6	1 2 3	1 2 3	1 2 0	1 1 0	0 19 0	0 18 9	0 17 6	1 1 2½
1908	0 16 6	0 15 0	0 15 6	0 15 6	0 15 3	0 15 0	0 15 0	0 14 9	0 15 0	0 16 0	0 16 0	0 16 0	0 15 5½
1909	0 15 9	0 16 3	0 16 0	0 16 0	0 16 3	0 16 6	0 16 0	0 16 0	0 17 0	0 17 0	0 17 6	0 17 6	0 16 6
1910	1 0 4	1 0 9	1 0 9	1 0 9	1 0 9	1 0 9	1 0 9	1 0 3	1 0 3	1 0 6½	1 1 3	1 1 5	1 0 9½
1911	1 1 2 2½	1 2 6	1 2 6	1 1 11½	1 0 11½	0 19 6	0 19 0	0 19 0	0 19 1½	0 19 6	1 0 0½	1 1 6½	1 0 7½
1912	1 2 3	1 2 6	1 2 6	1 1 1½	1 1 6	1 1 6	1 1 6	1 2 3	1 2 6	1 3 0	1 3 0	1 2 11	1 2 2½
1913	1 2 9	1 2 2	1 1 7½	1 1 6	1 0 8½	1 0 0	1 0 0	1 0 0	0 19 10½	0 19 1½	0 19 0	0 19 0	1 0 5½
1914	0 18 7½	0 18 0	0 18 0	0 17 9	0 17 6	0 17 6	0 17 1½	0 19 7½	0 18 11½	0 17 10½	0 18 7½	1 1 0½	0 18 5½
1915	1 7 7½	1 8 6	1 9 3	1 10 2½	1 8 6	1 6 4	1 5 10½	1 6 0	1 6 10½	1 10 8½	1 13 0	1 17 10	1 9 1½
1916	1 18 6	2 0 1½	2 2 6½	2 0 6½	1 15 0	1 16 3	1 18 0	1 18 0	1 18 0	—	—	—	—
1917	} Price Fixed												
1918													
1919	—	—	—	—	2 5 7½	2 14 4½	2 16 4½	2 14 0	2 13 4½	2 13 0	2 12 7½	2 11 9	—
1920	2 17 0	3 7 9	2 15 6	3 6 7	3 0 0	2 15 0	2 14 0	2 9 9	2 7 6	2 11 0	2 12 3	2 10 0	2 15 0
1921	2 1 0	2 0 1½	1 18 3	1 17 6	1 17 6	1 17 6	1 17 6	1 5 0	1 8 9½	1 7 9	1 7 0	1 7 0	1 13 8½
1922	1 6 7½	1 5 10½	1 6 11	1 7 0	1 7 0	1 7 0	1 5 3	1 4 9½	1 4 2½	1 3 3½	1 2 6	1 2 3	1 5 2½
1923	1 2 9½	1 4 6½	1 5 2	1 4 8½	1 4 6	1 4 0	1 3 6	1 3 0	1 3 0	1 3 0	1 3 2½	1 4 9	1 3 10½
1924	1 4 2½	1 4 0	1 4 0	1 3 7½	1 3 8½	1 3 6	1 2 11	1 2 6	1 2 1½	1 1 7½	1 2 3	1 2 6	1 3 1
1925	1 2 6	1 2 1½	1 2 0	1 2 0	1 2 0	1 1 6	1 0 6	1 0 0	1 0 0	1 0 0	1 0 3	1 0 10½	1 1 1½
1926	1 1 1½	1 1 6	1 1 6	1 1 3½	1 1 3	1 1 5½	1 1 6	1 1 6*	1 1 0*	1 1 6*	1 1 6*	*	1 1 4½
1927	1 2 1½	1 2 3	1 2 1½	1 2 0	1 2 0	1 2 0	1 1 7½	1 1 0	1 1 0	1 1 0	1 1 0	1 1 0	1 1 7½
1928	1 1 0	1 1 1½	1 1 11	1 2 4½	1 2 6	1 2 6	1 2 6	1 2 6	1 2 6	1 2 6	1 2 6	1 2 6	1 2 2½
1929	1 2 6	1 2 6½	1 2 11½	1 3 0	1 3 0	1 3 2½	1 4 0	1 4 8½	1 4 7½	1 4 6	1 4 6	1 4 3	1 3 7½
1930	1 3 3½	1 2 6	—	—	—	—	—	—	—	—	—	—	—

* Prices nominal.

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

PIG IRON

REGISTERED TRADE MARK

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-.

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

FOUNDRY Foreman desires a change in a similar capacity; has had control of all classes of metals; conversant with the most up-to-date methods of production. London area preferred.—Box 452, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Foreman desires position; experienced all branches Engineering, Motor and Jobbing work; thorough knowledge of cupola, mix grey iron, semi-steel, and non-ferrous metals by analysis; can estimate and fix piecework prices.—Box 468, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

TO Iron and Steel Founders.—Commercial Manager and Works Accountant open for immediate engagement; long and varied experience Estimating, Costing, Buying, and Sales Organisation; compilation of brochures and booklets; qualified accountant; good connection; prepared to take financial interest in established business, especially special castings. Write fully position offered.—Box 470. Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

WANTED, Practical Foundrymen in all districts to assist introduction and sale of well-known brand of Core Oil and Cream. Spare-time, part-time or whole-time agency will be considered. Liberal commission on business introduced.—Box 448, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

AGENCY.

ALLOYS.—Important firm in North Midlands with extensive connection amongst steel-makers and founders desire Agencies for sale of Alloys.—Reply to Box 458, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

PROPERTY.

11 ACRES WORKS SITE.

SHEFFIELD.

145,000 Sq. Ft. of SHOPPING,

Compact and Convenient.

SIDING CONNECTIONS

with L.M. & S. and L. & N.E. Rlys.

WELL-BUILT & COMMODIOUS OFFICES

Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.

Apply—

THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

MACHINERY.

WANTED, Secondhand Portable Sand-Slinger.—Send full particulars to Box 462, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

BRITANNIA Adjustable Moulding Machine wanted.—Price and full particulars to Box 466, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

TILGHMAN Tumbling Barrel Sandblast Plant, T.B.2 type, in new condition, used 6 months only; cost £420, offered at £180, including Compressor and all equipment.—A. Hammond, Foundry Machinery Merchant, Slough.

MACHINERY—*Continued.*

ONE "Thwaites" Rapid Cupola, as new, size 4, capacity 3 to 4 tons per hr., casing 3 ft. 6 in. dia., overall height 24 ft. 8 in., drop bottom with receiver at side. Price, with one set of bricks (new), £85.—Mobbs & Company, Limited (in Voluntary Liquidation), Lion Foundry, Northampton.

SAND MIXERS. — New and Secondhand Ask us to quote.—W. Brealey & Company, Limited, Prospect Works, Hawksley Avenue, Sheffield.

SANDBLAST Room Plant, 12 ft. x 9 ft., 8 ft. high, with N.V.3 Tilghman Separator and Cyclone, B.H.4 Tilghman Compressor and Receiver; entire plant as new, been little used; cheap to quick buyer.—Box 464, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

WORM-GEARED CRANE LADLES:—
48 in. by 44 in. by 50 in. deep.
44 in. by 38 in. by 44 in. deep.
36 in. by 34 in. by 34 in. deep.
Fitted with phosphor-bronze gears.
Several Hand Ladles, 4 to 15 cwt.
Harry, Wellfield, Llanelly.

FOUNDRY CUPOLA (unused), 5 ft. x 2 ft. dia., with firebricks, 4 in. Keith Blackman blower, belt driven, with connections; suitable for metal foundry, etc.; immediate delivery; low price.—J. T. Williams & Sons, Engineers, South Bermondsey Station, London, S.E.16.

2-TON Hand-operated Swing Wall Crane, effective radius 18 ft., with 2-ton travelling pulley block (Herbert Morris, Limited), £22.—Mobbs & Company, Limited (in Voluntary Liquidation), Lion Foundry, Northampton.

MAYER & SCHMIDT 9-in. x 24-in. Universal Grinder.
NAXOS-UNION 10-in. x 24-in. Universal Precision Reamer Backing-off Grinder.
No. 100 LUMSDEN Surface-Grinding Machine, planetary head.
No. 2 LUMSDEN Oscillating Grinder.
10-ton "BUTTERS" ALL-STEEL HAND DERRICK CRANE, 75-ft. jib; slewing gear.
40-ton "STOTHERT & PITT" STEAM TRAVELLING TITAN CRANE, constructed to lift full load at 50 ft. radius and 36 tons at 75 ft. radius; 24 ft. gauge.
HORIZONTAL DOUBLE-GEARED STEAM WINCHES, 4½ in. x 6 in. stroke to 10 in. x 15 in. stroke, suitable for hauling.
FOUNDRY LADLES, various types and sizes.
One 8-n.h.p. PORTABLE STEAM ENGINE AND BOILER.
16,000 ft. 1½-in. New Black Steel Screwed and Socketed Piping in lengths of 18 ft. and upwards.

(ASK FOR "ALBION" MACHINERY CATALOGUE.)

THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

MISCELLANEOUS.

GANISTER, best quality for cupolas, also for Steel Works.—Astbury Silica Company, "The Brooms," Park Lane, Congleton.

FLUORSPAR. — The Ideal Flux for all Foundry and Furnace work; supplied in crude lump, washed gravel or finely ground. Samples and prices from

A. BECK,
MINEOWNER, MATLOCK.

NON-FERROUS CASTINGS. — Inquiries solicited from the Trade. Prompt attention; first-class products; reasonable prices.—Precision Castings, Limited, Lincoln Street, Wolverhampton.

PATTERNS IN WOOD AND METAL for all branches of Engineering. Moulding methods carefully considered.—Furmston & Lawlor, Letchworth.

MISCELLANEOUS—*Continued.*

"PURIC" CUPOLA FLUX in Block Form cleanses and desulphurises all cupola mixtures. No increase in cost of mixtures, but actual saving obtained, owing to the production of better metal and owing to less wear on the furnace linings.

Over 600 foundries have testified to the advantage of using "Puric." Send for trial cwt.—Write, Beecroft & Partners, Limited, The Foundry Chemists, Retort Works, Mappin Street, Sheffield.

Foundry Consultants and Advisors. Analyses and Testing carried out at low rates at The Laboratories, St. Peter's Close, Sheffield.

PATENTS AND TRADE MARKS.

PROTECT YOUR IDEAS.—Free, Advice and Handbook on patenting inventions and registering trade marks by Registered Agent with 43 years' experience.—King's Patent Agency, Limited, 146a, Queen Victoria Street, E.C.4.

THE Owners of British Patents Nos. 226478, 254918, 267508 and 289209 for Improvements relating to Installations of Prime Movers are desirous of entering into negotiations with one or more firms in Great Britain for the purpose of exploiting the above invention, either by sale of the patent rights or by the grant of a licence or licences to manufacture on royalty.—Inquiries should be addressed to Messrs. Abel & Imray, 30, Southampton Buildings, W.C.2.

THE proprietor of British Patent No. 227338, dated April 30, 1924, relating to Improved Process and Apparatus for Disintegrating and Mixing Moulding Sand, is desirous of entering into arrangements, by way of a licence or otherwise, on reasonable terms, for the purpose of exploiting the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. Singer, Steger Building, Chicago, Illinois.

'Phone: 287 SLOUGH

MOULDING MACHINES

Two Britannia head ram machines	£24 each
Two No. 1 Britannia jar ram machines	£38 each
One 48" × 24" Darling & Sellars turnover	£28 (new)
One 24" × 20" Jackman hand turnover	£18

SAND PLANT

One "Herbert" ball-bearing sandmixer	£32
Two "Macdonald" electric gyratory sifters	£11 each
Two "Macdonald" pneumatic sifters	£11 each
Two 6 feet overdriven sandmills	£40 each

LARGEST STOCK OF FOUNDRY PLANT IN ENGLAND. PLEASE SEND FOR LISTS.

BUY FROM ME AND SAVE MONEY

ALEX. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH

RYLAND'S DIRECTORY

[2,200 pages 8½" × 5½"].

The standard work of reference covering the Coal, Iron, Steel, Tinplate, Metal, Engineering, Hardware and Allied Trades.

1930 EDITION NOW READY.

ORDER YOUR COPY NOW.
PRICE 42/- BOUND IN CLOTH.

INDUSTRIAL NEWSPAPERS, Ltd.
49 Wellington St., Strand, London, W.C.2.